Santa Clara Valley Water District

San Jose, CA

AN EVALUATION OF MtBE OCCURRENCE AT FUEL LEAK SITES WITH OPERATING GASOLINE USTS

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EXECUTIVE SUMMARY

The Santa Clara Valley Water District (District) is committed to ensuring that groundwater basins in Santa Clara County (County) and drinking water resources are protected from contamination of Methyl tert Butyl Ether (MtBE). The District's Leaking Underground Storage Tank (LUST) Oversight Program ensures that known releases of fuel (and MtBE) from underground storage tanks (UST) are investigated and cleaned up such that drinking water resources are protected. However, the possibility for undetected releases to occur from operating UST facilities appears to be substantial and has been documented by the District's MtBE Occurrence and UST Study and other relevant studies summarized in this report. Given the possibility for undetected releases to occur and result in significant MtBE contamination in groundwater, additional assessment was performed. This report contains summaries of relevant UST and MtBE occurrence studies and includes the results of a detailed case study of 16 leaking underground storage tank (LUST) sites with operating USTs and high concentrations of MtBE in groundwater. The objectives of the detailed LUST case study is to evaluate potential causes of significant MtBE contamination at operating UST facilities, including an evaluation of whether undetected releases are occurring and identification of actual and potential weaknesses in fuel storage, management, and delivery operations.

The intent of this work is to provide information that can be used to identify and correct weaknesses in fuel UST management and recommend strategies to detect MtBE releases. Increased effectiveness in pollution prevention techniques and pollution prevention programs is the first line of defense in maintaining the high quality of the District's groundwater resource. This project is consistent with the District's core functions of delivering safe drinking water to the Santa Clara Valley and ensuring that the groundwater basins are protected.

BACKGROUND

MtBE is a synthetic organic ether that has been added to gasoline since the 1970s first as an octane enhancer after the phase out of lead (U.S. EPA, MtBE FAQ1), and more recently as a result of federal and state clean air requirements. Since 1995, responsible parties have been requested to analyze groundwater samples for MtBE in conjunction with investigation and monitoring activities associated with releases at LUST sites in Santa Clara County. This groundwater analytical data is submitted to the District's LUST Oversight Program. As this data was reviewed and entered in to the District's database, staff began to observe disturbing trends in the occurrence of MtBE at LUST sites with gasoline USTs still in use, particularly at retail gasoline facilities. These trends include high rate of detection, increasing concentration trends, and distribution of MtBE in groundwater.

LUST CASE STUDY

The objectives of each detailed LUST case study include: 1) determine whether detection of high concentrations of MtBE in groundwater at LUST sites is a result of undetected releases from new or upgraded UST systems, and 2) identify whether potential weaknesses in new UST systems and leak detection monitoring systems exist and if so, where these weaknesses are most likely to exist.

District staff reviewed available MtBE data for more than 150 LUST sites with operating USTs to select a final study population of 16 sites. The case study presented in this paper examines a population of 16 LUST sites with operating UST systems and high concentrations of MtBE in groundwater to evaluate the most reasonable source and cause of the MtBE contamination. The study sites were evaluated in detail to determine whether new releases were occurring and not being detected by the monitoring system. Both UST and LUST files were reviewed for release history information. The UST files were reviewed to obtain UST system construction, UST system monitoring, and facility compliance information. LUST case files were reviewed to identify contaminant trends and location of potential source areas. An evaluation of the available data was conducted in an attempt to identify potential source locations, possible release scenarios, and whether an undetected release was likely to have occurred.

SUMMARY OF FINDINGS

The results of the 16 case studies reveals that 13 sites are suspected of having had an undetected release from the current UST system and 2 sites are suspected of a pre-upgrade undetected release. The degree of certainty regarding the conclusions varies, but in general, an undetected recent release is the most reasonable explanation of the high and recently increased MtBE concentrations at the majority of these sites.

Two of the sites with significant MtBE plumes were only discovered to have had a release because of significant nuisance conditions that warranted investigation. In one case, vapors in an off-site sewer prompted investigation of the USTs. In another case, detection of MtBE in a nearby municipal well prompted investigation of the site. The release locations for these 2 sites have been confirmed. In one case, a leak in the primary piping drained to the Submersible Turbine Pump (STP) sump but was not contained or detected. In the other case, the owner has identified the release mechanism as a vapor release that was related to the vapor recovery system and potential breaches in various portions of the system.

A specific release mechanism could not be definitively identified for the other 14 sites. Two other sites that conducted detailed testing of secondary containment portions of the system found components that were not liquid tight (dispenser pans and turbine sumps), but a release from these components was not confirmed. An attempt was made to determine the most likely source location and release scenario resulting in significant MtBE concentrations at each of the 14 sites. An evaluation of the available data indicates the following suspected source areas:

- Twelve of the sites appeared to have source locations around the tank complex. Five of these are suspected of having releases associated with inadequate or absent sumps around the STP.
- Two sites appeared to have problems associated with the lined trenches.
- Two sites appeared to have source areas located around the tanks and piping
- Three sites appeared to have source areas near the piping/dispenser
- One site had inconclusive data

At least 7 of the 16 study sites had notices of violation or problems noted by the inspector related to monitoring system components. Four other sites had performed third party inspections which resulted in finding components that were either not liquid tight or not vapor tight.

All of the 14 case study sites that have had increasing trends of MtBE were cases where the original release was reported prior to 1990 and the tanks and piping were replaced prior to 1992.

CONCLUSIONS

The results of this study show that new or upgraded USTs do not afford 100 percent protection against fuel releases and UST monitoring systems are not necessarily effective in detecting releases, even for those sites which appear well maintained and operated. The results of the detailed LUST case study discussed in this report and the District's MtBE and UST Pilot Study indicate that for these recent and undetected releases, MtBE is the most significant fuel constituent detected in groundwater.

Review of overall groundwater data reported for operating gasoline facilities in Santa Clara County indicates a disturbing rate of occurrence and magnitude of MtBE in groundwater compared to sites no longer storing or dispensing fuel. The results of the detailed LUST case studies reveals that significantly increasing MtBE contaminant trends appear to be the result of undetected releases from new or upgraded UST systems. It is important to note that these high levels of MtBE contamination would not have been detected if environmental investigation or monitoring had not been conducted as part of a previous investigation and cleanup directives. The exception was for two cases where the MtBE contamination was only discovered due to nuisance conditions (vapor in sewer and water well impact) that prompted investigation of the sites.

For 13 of the 16 study sites, the specific causes of MtBE contamination cannot be definitively determined, but an undetected release was judged to be the most reasonable scenario based on the case study review. Inadequate or lacking secondary containment and improper monitoring seem to be a common theme associated with suspected undetected MtBE releases. Even with detailed system inspections and component testing, the release mechanism often remains elusive. However, detailed analysis of site specific data and UST inspection and compliance information does help to resolve some questions regarding potential sources and/or timing of releases.

Results of this and similar studies referenced in this report indicate the need for increased vigilance in maintaining, operating and inspecting UST facilities. Overall, the release mechanisms for MtBE at most LUST sites with MtBE in groundwater are not well understood. Due to the potential for undetected releases to continue to occur, and the occurrence of undetected releases that have not been identified, groundwater resources will continue to be threatened by the continued use of MtBE, or similar additives in gasoline.

RECOMMENDATIONS

The results of this and similar studies should be used to assess the threat to water resources posed by storage of fuels in USTs and the operation of fueling facilities. The level of threat posed is also directly related to the chemical properties of the fuel constituents**. Common areas of weaknesses in UST systems exist and have been identified by this and similar studies. Resources should be directed to those areas that present the most significant threat to water resources**

Whereas most of the cases examined in this study had double-walled tanks and piping, **particular attention should be paid to single-walled tank and piping systems which have no protection against low volume leaks** that may not be detected by monitoring systems or integrity testing.

Specific vigilance should be paid to these facilities. Conversely, **the mere presence of a double-walled UST system should not be considered guaranteed protection against undetected and/or significant releases.** It is imperative that secondary containment components are tested to determine if they are effective in containing and detecting leaks.

Fluctuating concentrations of MtBE in groundwater are observed at many operating LUST sites and can increase or decrease by orders of magnitude over a 1-year period. The reasons for such fluctuations are not clearly understood, and are seldom properly investigated or reported. The fluctuations observed at the study sites appear to be related to undetected releases at sites where UST are still present. **State and regional LUST program managers should carefully weigh the uncertainty associated with such reported groundwater monitoring data and consider the possibility of continuing releases prior to closing cases or in considering whether to re-open closed cases.** These considerations may include a review of facility management practices, appropriateness of existing groundwater monitoring well networks, release history, and underlying aquifer sensitivity the site.

The severity of MtBE contamination examined in this LUST population cannot be presumed to exist at all UST facilities. However, the District's Pilot Study of MtBE Occurrence Associated with Operating UST Systems found that minor to significant levels of MtBE contamination in groundwater can result from undetected releases at non-LUST sites and that MtBE could be present at up to 50 percent of the operating UST sites. This study found that high concentrations of MtBE contamination in groundwater appear to be the result of undetected releases at many sites. To verify if undetected releases have occurred at non-LUST sites and to determine the level of MtBE contamination, environmental monitoring (in this instance sampling of groundwater) is necessary. This should involve the collection of both soil and groundwater samples.

There is not currently a requirement for operating UST facilities to conduct environmental monitoring at non-LUST sites. Environmental monitoring should be considered the only method to confirm the presence of MtBE in groundwater and evaluate the threat that past and continuing undetected releases pose to groundwater resources. **The investigation of MtBE occurrence at all operating UST sites and gasoline stations should be a priority for any groundwater protection program in areas where MtBE or similar chemicals have been or are added to gasoline. In vulnerable groundwater areas the identification of these "undetected" MtBE groundwater plumes should be the foremost groundwater protection priority.**

1.0 MtBE USE AND OCCURRENCE

This section provides background information on the use of MtBE in the Bay Area, MtBE occurrence in groundwater and drinking water supplies, and briefly summarizes the physical characteristics of MtBE. In addition to the MtBE occurrence data, relevant UST studies are examined and summarized. The information provided in this section provides a foundation and support for the detailed LUST case study presented in this paper.

1.1. INTRODUCTION

MtBE is a synthetic organic ether that has been added to gasoline since the 1970s first as an octane enhancer after the phase out of lead (U.S. EPA, MtBE FAQ1), and more recently as a result of federal and state clean air requirements. MtBE has been detected in water supply wells across the state and the nation since the early to mid 1990s (U.S. EPA Blue Ribbon Panel). MtBE is most often found in shallow groundwater at gasoline storage facilities where releases or spills associated with Underground Storage Tanks (USTs) have been reported. Releases of MtBE from UST systems have also been associated with impacts to drinking water sources. Many of the UST system releases associated with the water supply impacts were only discovered after MtBE was detected in the water supply wells (i.e., the release was not detected by the UST system operator and/or monitoring system).

Since 1995, responsible parties have been requested to analyze groundwater samples for MtBE in conjunction with investigation and monitoring activities associated with releases at LUST sites in Santa Clara County. This groundwater analytical data is submitted to the District's LUST Oversight Program. As this data was reviewed and entered in to the District's database, staff began to observe disturbing trends in the occurrence of MtBE at LUST sites with gasoline USTs still in use, particularly at retail gasoline facilities. These trends include the high rate of occurrence, increasing concentration trends, and the increased extent of MtBE in groundwater at LUST sites with operating UST systems. District staff and other regulators across the State began to suspect that some LUST sites with unexplained high MtBE concentrations may have contamination that is not associated with previously known reported releases, but possibly related to more recent unreported or undetected spills or releases from the current UST facility operations.

The District determined that further assessments were needed to evaluate whether high concentrations of MtBE in groundwater at LUST sites are associated with known releases (i.e., previously reported or detected) or may be a result of recent or ongoing, undetected releases from new or upgraded UST systems (as defined by the U.S. EPA Federal Underground Storage Tank Regulations and California Code Of Regulations, Title 23 Waters, Division 3 Water Resources Control Board, Chapter 16 Underground Storage Tank Regulations). The case study presented in this paper examines a population of 16 LUST sites with operating UST systems and high concentrations of MtBE in groundwater to evaluate the most likely source of the MtBE contamination. These 16 LUST cases reviewed were selected from over 40 cases identified as potential study sites based on the concentration of MtBE detected in groundwater at those sites and information regarding MtBE data, UST system information, and fuel leak history. Results of this case study, along with other related studies, will be useful to better understand the potential sources of MtBE at operating gasoline storage facilities and to confirm speculations that current UST systems have weaknesses in the areas of release prevention and detection. In addition to the case study, this paper provides background information regarding MtBE use in the Bay Area, physical properties of MtBE, MtBE occurrence data, and results of relevant MtBE and UST related studies.

1.2. MtBE USE IN THE SAN FRANCISCO BAY AREA

Information regarding the introduction of MtBE into Bay Area gasoline was obtained during meetings held between the District and several retail oil companies during 1996 and 1997. The information is assumed to be accurate, but has not been verified. Similar information was also submitted to the San Francisco Bay Regional Water Quality Control Board. Several of the oil companies which were able to supply information regarding MtBE use in the Bay Area, indicated that prior to the mandated wintertime oxygenate period in 1992, MtBE use by volume was 0 to 1.5 percent from 1982 to 1988. From 1989 to 1992, MtBE volume in gasoline was dependent on the company and the volume added is unknown, but expected to be less than that during the mandated wintertime oxygenate period. During the wintertime introduction period from 1992 to 1995, most gasoline contained up to 8 percent by volume. However, some companies opted to use ethanol rather than MtBE. Since the year-round introduction of MtBE in Bay Area gasoline in 1996, the percent by volume has been between 11 and 15 percent, with MtBE as the primary oxygenate in most cases. In 1998, the District collected gasoline samples at the 12 gasoline storage facilities in Santa Clara County. Results indicate that the volume of MtBE in lower octane fuels is being voluntarily reduced by some oil companies. These results have been confirmed in conversations with oil industry representatives.

1.3. PHYSICAL PROPERTIES OF MtBE

MtBE is currently the most commonly used ether oxygenate in gasoline due to its high-octane properties, blending characteristics, and availability. MtBE is a volatile, colorless liquid with a turpentine like odor. MtBE, when compared to Benzene, Toluene, Ethylbenzene, and Xylenes, (BTEX), is more soluble in water, more volatile, less likely to absorb into soil, and much less likely to biodegrade. The combination of these characteristics makes MtBE more mobile in the subsurface, less prone to natural attenuation, and able to move at or near groundwater flow velocities (P. J. Squillace, et al).

MtBE is highly volatile (vapor pressure 245-256 (millimeter of mercury) mmHg, Henry’s Law Constant 5.5 x 10-4 atmospheric (atm)-meter 3 (m3)/mole), and would be expected to volatilize rapidly from soil surfaces or water (U.S. EPA, 1993). Calculations based on the environmental partitioning model (ENPART) in the Graphical Exposure Modeling System (GEMS) indicate that 99.99 percent of MtBE will partition to air (U.S. EPA 1993a). However, MtBE leaking from underground gasoline UST systems may not readily reach the atmosphere. With a relatively low organic carbon partitioning coefficient (Koc), (estimated to be 12.3 derived from water solubility data and 10.96 derived from Kow data) (U.S. EPA 1993a), MtBE is expected to be highly mobile in soils, and leaching of the chemical into groundwater is likely (U.S. EPA 1993a). MtBE is also highly soluble relative to other gasoline constituents. The known solubility of neat MtBE is 43,000 milligrams per liter (mg/l) and the effective solubility of MtBE (MtBE 11 percent by volume in gasoline) is 5,100 mg/l (Busheck).

1.4. MtBE OCCURRENCE IN CALIFORNIA GROUNDWATER

MtBE has been detected in both drinking water sources and shallow groundwater in California since the early to mid 1990s. This section provides a summary of the occurrence of MtBE in drinking water sources and in shallow groundwater at LUST sites in California and Santa Clara County.

1.4.1. MtBE Occurrence in California Drinking Water Sources

The California Department of Health Services (DHS) maintains a database of drinking water contaminants. A summary of MtBE detections in drinking water supplies is available on their web site: http://www.dhs.cahwnet.gov/ ps/ ddwem/ chemicals/ MTBE/ mtbe_ overview. Htm. Current status of monitoring public water systems and sources for MtBE as of January 6, 2000:

Current status of monitoring public water systems and sources for MtBE

Sampling Status	Number of Systems or Sources
Systems sampled for MtBE	1,444 of 4,681 (31%)
Systems reporting detections	30 of 1,444 (2.1%)
Groundwater (GW) sources sampled	6,076 of 10,972 (55%)
GW sources with MtBE detections	31 of 6,076 (0.5%)

[Public Water System (also Drinking Water System): A system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year.]

[Source Water: Water drawn to supply drinking water from an aquifer by a well or from a surface water body (e.g., reservoir, lake, or river) by an intake.]

As shown above, 2 percent of the public water system sampled detected MtBE. A lower percentage (0.5 percent) of the groundwater sources sampled contained MtBE.

1.4.2. MtBE Occurrence in Santa Clara County Drinking Water Wells

To date, two public drinking water supply wells have been contaminated with low concentrations of MtBE in Santa Clara County. The District has requested water retailers to report any detection of MtBE. To obtain additional data, the District has conducted two well sampling programs for MtBE.

The first study was the Free Well Water MtBE Testing Study. The primary purpose of the study was to provide interested domestic well owners (within a ½ mile of a LUST site) with information about their drinking water quality. Well sampling was therefore conducted on a voluntary basis. The study's secondary purpose was to produce additional data regarding the occurrence and extent of MtBE contamination of groundwater in Santa Clara County. Out of 301 eligible wells, 51 wells were tested. Of the 51 wells tested, 4 wells contained detectable concentrations of MtBE. This corresponds to an 8 percent detection rate, much higher than the DHS' California data presented in Section 1.4.1. The detected concentrations for the four wells were 9.8 micrograms per liter (µg/L), 1.6 µg/L, 1.9 µg/L, and 3.9 µg/L (Santa Clara Valley Water District, April 1999). The higher detection rate would be expected since only wells near LUST sites were sampled.

The second study was a Focused Groundwater MtBE Monitoring Program. The purpose of this study was to determine the extent of MtBE contamination in deeper aquifers in Santa Clara County. The study focused on monitoring small and distinct regions in the County, including different combinations of well depths, hydrogeology, past and present land uses, densities of operating USTs, and leaking USTs. Five monitoring areas, each approximately four square miles included 104 existing wells (deep monitoring wells and supply wells) that are sampled every 6 months. The study was initiated in 1999 and to date, there have been no verifiable detections of MtBE based on a 3-µg/L detection limit. The study is currently ongoing. (Santa Clara Valley Water District, October 1999).

1.4.3. MtBE Occurrence in Groundwater at LUST Sites in California

A study of MtBE in groundwater at LUST sites conducted by Lawrence Livermore National Laboratory (University of California) indicates MtBE detections at 78 percent of these sites, based on data reported in 1995 and 1996. Maximum concentrations found at these sites ranged from several micrograms per liter (µg/l) to approximately 100,000 µg/l. The report concludes that "…this oxygenate is a likely contaminant at the majority of LUST sites in California where fuel hydrocarbons have impacted groundwater…" (A. Happel, et al).

1.4.4. MtBE Occurrence Data at LUST Sites in Santa Clara County

MtBE data has been tracked in Santa Clara County since 1995. The District's Local Oversight Program has over 2250 LUST sites listed on its database. To date 65 percent of the LUST cases have been closed. This database was utilized to generate statistical information relating to the occurrence of MtBE in groundwater at these sites. The data is updated from monitoring reports submitted by the LUST case responsible party. To date 717 of the total 2,250 sites have sampled for MtBE with 486 sites detecting MtBE. Tables 1 and 2 present data on the remaining 460 open LUST sites monitoring for MtBE in groundwater. MtBE concentration statistics calculated in 1997 and 2000 are presented. The most significant observation from the data is the higher detection rates and higher maximum MtBE concentrations at LUST sites with operating USTs compared with LUST sites no longer storing or dispensing fuel. A comparison between the two data sets shows an increase in detections and an increase in maximum concentration at operating LUST sites.

Table 1: 1997 Santa Clara County MtBE Occurrence Data in Groundwater at LUST Sites

	LUST Sites (Total)	**LUST Sites Operating** UST	LUST Sites **Non-Operating** UST
Number of Sites Detecting MtBE	276	141	135
Percent of LUST Sites Monitoring for and Detecting MtBE	77%	88%	69%
Highest MtBE Concentrations (in µg/l) as of **October 1997**			
1 to 35	46 (17%)	16 (11%)	30 (22%)
36 to 350	72 (26%)	21 (15%)	51 (38%)
351 to 3,500	100 (36%)	56 (40%)	44 (33%)
3,501 to 35,000	43 (16%)	34 (24%)	9 (7%)
35,001 to 430,000	15 (5%)	14 (10%)	1 (1%)

Table 2: 2000 Santa Clara County MtBE Occurrence Data in Groundwater at LUST Sites

	LUST Sites (Total)	LUST sites **Operating** UST	LUST sites **Non-Operating** UST
Number of Sites Detecting MtBE	387	222	165
Percent of LUST Sites Monitoring for and Detecting MtBE	84%	93%	70%
Highest Groundwater Concentrations (in µg/l) as of **April 2000**			
1 to 35	64 (17%)	30 (14%)	34 (21%)
36 to 350	66 (17%)	17 (8%)	49 (31%)
351 to 3,500	131 (34%)	70 (32%)	61 (38%)
3,501 to 35,000	80 (21%)	62 (28%)	18 (11%)
35,001 to 4,020,000	46 (12%)	43 (19%)	3 (2%)

1.5. MtBE AND UST RELATED STUDIES

The purpose of this section is to summarize and present results of MtBE and UST related studies. The results of the following studies add to the conclusions and significance of the findings presented in this report.

1.5.1. Review of Operating LUST Sites Never Detecting MtBE in Groundwater

As part of this report and detailed case study, LUST sites with operating USTs and no detectable MtBE in groundwater were evaluated. The intent of reviewing this population of sites was to identify facilities which don't appear to be having undetected releases of MtBE and evaluate the conditions of the facility. As of September 1999, there were 12 open LUST sites verified as having operating gasoline UST systems that were monitoring for MtBE in groundwater and that had not reported any detectable concentrations. Available groundwater monitoring data, monitoring well network construction and layout, and UST system type were reviewed for each of the 12 sites. Of the 12 cases reviewed, only five were periodically analyzing for MtBE (3 quarterly and 2 annually). The other 7 sites had only one or two monitoring events for MtBE. Of the 5 operating sites with periodic data, only three had monitoring wells downgradient of the new UST system because the monitoring well network was designed for the release at the former UST location. Two of these sites had shallow groundwater and one has groundwater in excess of 100 feet below ground surface (bgs).

In summary, only 2 of the 12 cases had sufficient MtBE monitoring data and monitoring well layouts to conclude that there is no evidence of an undetected release from the current UST system and that MtBE has not impacted groundwater. Considering the small population, further site specific analysis was not warranted. However, this data indicates there are few operating LUST sites with no detectable MtBE that have adequate monitoring well networks to detect MtBE in groundwater. In addition, due to significant detection frequencies and concentrations of MtBE at operating sites, it may be useful for LUST program managers to review open sites with non-detectable concentrations of MtBE to determine if the current monitoring well networks are adequate to detect new MtBE releases from the current UST system.

1.5.2. Report of the State Water Resources Control Board's (SWRCB) Advisory Panel on the Leak History of New and Upgraded UST Systems, January 1999.

Knowledgeable people in the areas of UST inspection and operation, and in contamination issues were convened by the SWRCB to determine whether MtBE is being release from upgraded or new UST systems. The panel was divided into three work groups or teams. The teams covered the following areas:

- UST Team 1 examined whether the materials of the UST systems and their components may be compromised, by permeability or compatibility, by MtBE and other oxygenates.
- UST Team 2 reviewed petroleum release sites with MtBE contamination in the soil and groundwater, and look for specific problems associated with the UST system.
- UST Team 3 investigated the ability of the upgraded systems to detect and prevent leaks into the environment.

Team 2 of the panel reviewed 26 case files and conducted 22 site inspections. Apparent problems or leaks discovered during site inspections were documented. These were related to faulty installations, poor maintenance, and poor operations. Some of the sites inspected were only nominally in compliance with the 98 requirements (i.e. no dispenser pans, sumps not installed to be liquid tight, steel unions on fiberglass piping, etc.).

Specific problems identified during inspections by Team 2 included:

- Leaking STP sumps and fuel dispensers
- Improperly installed piping (particularly joints)
- Ineffective monitoring systems for trench-lined single-walled piping
- Leak rate detection thresholds for piping that may be too high to detect small leaks
- General installation problems

Team 3 of the panel reviewed the Leaking Underground Storage Tank Information System (LUSTIS) database and conducted a survey of inspection records to generate statistics on the ability of upgraded or new UST systems to detect and prevent leaks into the environment.

The following is a brief excerpt from the findings in the Team 3 Report:

- Releases are mainly associated with older, non-compliant systems.
- Piping, particularly near the dispenser, remains the most problematic release source.
- Releases are still mostly discovered during closure or removal operations. Just 4.5 percent of the releases in the LUSTIS database and only 0.7 percent of those in the inspection database were discovered by UST system leak detection activities.

Specific recommendations in the full panel report include:

- Funding additional study to evaluate the integrity/compatibility of double-walled tanks.
- Develop State regulations/guidance for proper installation and inspection of sumps.
- Require that all secondary trench lined systems be properly maintained, monitored, and periodically tested for tightness.
- Require that all secondary containment systems be properly maintained, monitored, and periodically tested for tightness.
- Investigate all single wall systems to ensure that they were properly installed.
- Develop a phase-in approach to ensure dispenser containment is properly installed, maintained, and periodically inspected at all facilities
- Develop better testing methodologies for single wall piping systems.

The Advisory Panel report reveals that there are many weaknesses in the area of UST construction, operations, and leak detection. (State Water Resources Control Board, January 1999)

1.5.3. MtBE Occurrence and Operating UST Pilot Study, LFR-Levine-Fricke, June 1999

This study was commissioned by the District to determine the occurrence and magnitude of MtBE contamination at operating gasoline facilities with no history of a previous gasoline release. Twenty-eight facilities in Santa Clara County were investigated. Soil and water samples were collected at 27 sites.

MtBE was detected in groundwater at 13 of the 27 at concentrations ranging from approximately 1 µg/L to 200,000 µg/L. Of the 13 sites with detections in groundwater, 5 had maximum concentration of MtBE over 1,000 µg/L, and only 2 sites had MtBE at concentrations less than 5 µg/L—the State of California secondary Maximum Contaminant Level for Drinking Water.

A detailed evaluation of the UST construction and MtBE data was performed and a correlation was found between an increased likelihood of MtBE occurrence in groundwater and the presence of assisted vapor recovery systems or single-walled system components (UST and/or piping). The analysis also revealed a decreased likelihood of MtBE occurrence at private fueling facilities.

Additional review of MtBE occurrence relative to these three facility characteristics (vapor recovery system, single-walled system components and facility type) revealed that of the 13 sites with MtBE in groundwater, 11 have single-walled system components (includes piping in a fiber trench), and/or assisted vapor recovery systems.

The results of this study indicate that MtBE was detected in the groundwater at nearly half of the study sites. Although this MtBE detection occurrence rate cannot directly be applied as a probability of a release from upgraded or new UST facilities, it is reasonable to consider that approximately 50 percent occurrence frequency measured during this study should be representative of the population of UST facilities in Santa Clara County. The study results indicate that facilities with upgraded UST systems, with little or no history of release, can represent significant threats to groundwater resources. (LFR-Levine-Fricke, June 1999)

1.5.4. Survey of Current UST Management and Operation Practices

This survey was commissioned by The California MtBE Research Partnership. The report presents the results of a literature search regarding UST management and operation practices and included a one-day workshop that consisted of 21 UST experts. An extensive summary of potential problems, suggestions for improvement and recommendation for further research were included in the report. Over 125 potential problems were identified in the area of UST operation and maintenance practices, and more than 110 problems were identified in the area of UST design and installation. Some of the key problem areas discussed under UST operation and maintenance activities included: delivery and dispensing spills; leak detection system/inventory control problems; vapor recovery system problems, and spill response. Also, in light of MtBE, special release considerations were highlighted, including small/subtle leaks and vapor losses. The report states that small continuous releases are one of industry’s major challenges and that the leak detection system thresholds are too high when chemicals such as MtBE are used (Alpine Environmental, December 1999).

2.0 CASE STUDY DESCRIPTION

The objectives of each detailed LUST case study include: 1) determine whether the detection of high concentrations of MtBE in groundwater at LUST sites is a result of undetected releases from new or upgraded UST systems, and 2) identify whether potential weaknesses in new UST systems and leak detection monitoring systems exist and if so, where these weaknesses are most likely to exist. In order to achieve these goals, LUST site cases were reviewed to identify sites that were ultimately selected for this detailed study.

MtBE concentrations and trends were used as a potential indicator of a new or recent release of petroleum hydrocarbons. The District provides oversight for over 200 LUST cases with operating USTs that have detected MtBE in groundwater. Of these cases, over 40 cases were identified as potential study sites based on MtBE concentrations. Based on review of additional information for each site, as described below, a final population of 16 LUST sites was identified for more detailed examination. This section describes the site selection criteria, selection process, and cursory examination of data from the study population. Results from the case study review are presented in Section 3 and a summary of findings is presented in Section 4. The individual case reviews are presented in Section 7.

2.1. CASE REVIEW PROCESS

Both UST and LUST files were reviewed for release history information. In addition, the UST files were reviewed to obtain UST system construction, UST system monitoring and facility compliance information. Quarterly groundwater monitoring reports and recent subsurface investigation reports were reviewed to identify contaminant trends and location of potential source areas. Isoconcentration contours were hand drawn and soil contamination data (when available) was reviewed. A subjective evaluation of the available data was conducted in an attempt to identify potential release scenarios, possible source locations, and whether an undetected release was likely to have occurred.

Individual case review summaries are presented in Section 7. The summaries contain the following information:

- Case ID
- Fuel Leak History
- Total Petroleum Hydrocarbons as Gasoline (TPHG)/MtBE Trend Analysis
- UST System Information
- Suspected Release Scenario
- Conclusion

2.2. CASE STUDY SELECTION CRITERIA

In order to identify sites that may have had an undetected release from a 1998 upgrade compliant UST system, the selection criteria presented below were used to screen the entire open LUST site population (almost 800 sites). The screening was performed to develop the most useful study set of cases where it was most likely that an undetected release occurred. The basis for using the site selection criteria is presented.

First Cut Screening

- High MtBE concentrations, generally greater than 35,000 µg/L in groundwater.

  Basis: To assist in identifying potentially recent or ongoing releases, it was necessary to identify a dissolved MtBE concentration in groundwater that could indicate a recent and possibly small release that went undetected. Based on the District's LUST data set comparison of operating verses non-operating USTs (Table 1 and Table 2), 35,000 µg/L (35 mg/l) MtBE is deemed suitable for screening cases to identify potential recent or ongoing releases associated with operating LUST systems. [19 percent of operating UST sites verses 2 percent of non-operating LUST sites had a concentration above 35,000 µg/L–Table 2]

- Operating UST system, preferably replaced or upgraded prior to 1992

  Basis: To reduce the potential for study sites to have had releases from non-upgraded USTs during the period where MtBE volume in gasoline was high. A known period of significant volume of MtBE in gasoline in the San Francisco Bay Area (Section 1.3) was in 1992. This will help rule out the cause of high MtBE from known previous releases.

Second Cut Screening

In an attempt to screen out sites with high MtBE concentrations that may have resulted from previously known releases, the following criteria were applied to the population derived from the first cut selection.

- Generally increasing (or increased) MtBE concentrations

  Basis: known/expected dissolution, transport, and solubility of MtBE. MtBE is expected, based on its properties, to migrate through the vadose zone to groundwater before the other constituents of gasoline. Once in the groundwater, MtBE is expected to migrate with the groundwater and generally away from the source area. Therefore, at a site with a known release prior to 1992, more than 6 years ago, increasing concentrations of MtBE in groundwater near the source area would not be expected, particularly where the other petroleum constituents have declined or have been in groundwater for some time. Recently detected high and increasing MtBE concentrations in groundwater near the source area at such a site may indicate a new or recent release. An attempt was made to find sites with increasing concentration trends over several monitoring events during the period of 1997 to 1999.

- Generally stable and significant concentrations of MtBE

  Basis: known/expected dissolution, transport, and solubility of MtBE. Continuing high concentrations near the suspected source area, together with increasing concentrations in downgradient wells could suggest that an ongoing release or significant MtBE source is present.

- Tank system upgrades complete or almost complete and/or release stopped prior to 1992.

  Basis: Former known release from previous UST system and release stopped prior to significant introduction of MtBE (Section 1.3). Also, if the old release was stopped prior to 1992, increasing MtBE concentrations would not be expected to be from a release more than 6 years old, especially in areas of shallow groundwater where MtBE transport would occur over a short time period.

Third Cut Screening

In order to assist in identifying the potential release scenario, the following optional criteria were applied.

- Isoconcentration contours depict current tank system as potential source location

  Basis: To have the ability to differentiate the old release from a release associated with a new UST system. In some cases separate plumes can be identified where the isoconcentration contours for MtBE do not originate at the same source area as the historic releases. Many times the new tank system is in a different location or the release point may be different than the historic release. This is further evidence of new or recent releases from newer tank systems.

- Local agency inspection records or release reports indicate potential releases or insufficient UST leak detection monitoring.

2.3. STUDY SET SELECTION

2.3.1. First Cut Screening Results

As described in the Site Selection Criteria Section (2.2), the LUST sites chosen for detailed review in this study would ideally have a historical maximum MtBE concentration greater than 35,000 µg/L and have operating USTs. As of May 1998, there were 27 cases meeting this criterion. Of the 27 cases, 23 had operating USTs. As of August 1999, 17 more sites appeared to meet the first cut criteria, for a total of 40 potential study sites.

2.3.2. Final Case Study Sites Selected

Approximately 30 file reviews were conducted at the local permitting agencies to verify UST system status, construction, monitoring and testing compliance for most of the sites. Some of the potential study sites were not included in this review because available information indicated the site would not meet the remaining criteria. Others were not reviewed because files were not available.

After the UST file reviews, 25 sites were selected for detailed LUST case file review (contaminant investigation, monitoring, and cleanup record) to identify release history information and contaminant trends. Two sites were screened out initially due to lack of sufficient groundwater monitoring data to establish trends. Seven additional sites were eliminated from further consideration when it was determined that releases had been discovered during recent upgrade work or if groundwater monitoring data indicated significantly decreasing MtBE concentration trends. The resultant study population consists of 16 sites.

Of the 16 sites selected for the study, 14 have had MtBE concentrations greater than 100,000 µg/L, well above the site selection criteria. All of the sites appeared to at least nominally meet the 1998 Upgrade requirements. Seven of the sites had fully double contained UST systems, including dispenser pans and overspill and overfill prevention components. Only 3 sites had previous releases that were discovered by leak detection equipment. Recent analytical and UST system data summaries of the sites studied are presented in Tables 3 and 4.

Table 3: Summary of Release Information and Groundwater Data for Selected Study Sites (µg/L)

Site No.	Date Former Release Reported	How Release Discovered?	Year UST system Upgraded/ Replaced	High MtBE	Date	Current MtBE	Date	High Benzene	Current Benzene	High TPHG	Current TPHG	Depth to Water
1	02/02/1993	GW Investigation	1990	430,000	3/5/1997	75,500	5/11/1999	2,100	360	480,000	60,000	10.95
11	12/04/1986	UST Removal	1985	405,000	7/29/1999	405,000	7/29/1999	5,400	14	110,000	79	31.77
7	02/12/1986	UST Removal	1986	280,000	4/6/1998	167,000	1/7/1999	800	1,100	78,000	8,300	10.67
2	07/17/1995	Nuisance (vapors)	1987	260,000	1/30/1997	47,000	5/10/1999	42,000	23,000	580,000	170,000	16.78
28	06/18/1986	UST Removal	1988	210,000	2/9/1999	19,000	5/4/1999	6,900	180	240,000	8,000	9.35
29	01/08/1986	Leak Detection Equipment	1988	200,000	6/9/1999	200,000	6/9/1999	13,000	1,500	380,000	20,000	7.62
22	01/20/1988	UST Removal	1987	170,000	9/16/1998	23,000	3/10/1999	290	<100	7,500	<10,000	9.77
3	02/01/1988	Leak Detection Equipment (GW well)	1989	120,000	3/7/1997	40,000	12/9/1998	67,000	1,400	1,500,000	57,000	7.2
10	06/30/1988	GW Investigation	1991	110,000	5/7/1998	100,000	8/28/1998	120	37	1,300	640	6.72
8	10/15/1986	GW Investigation (Installation of leak det)	1988/1999	140,000	12/19/1996	58,000	5/6/1999	2,300	15	19,000	3,100	10.49
5	12/16/1983	Leak Detection (Inventory Loss)	1991	140,000	2/23/1998	54,800	6/16/1999	160	6	27,000	2,700	9.22

Site No.	Date Former Release Reported	How Release Discovered?	Year UST system Upgraded/ Replaced	High MtBE	Date	Current MtBE	Date	High Benzene	Current Benzene	High TPHG	Current TPHG	Depth to Water
6	01/20/1998	Nuisance (water well impact)	1990	140,000	7/6/1999	5,600	7/6/1999	2	<1	290	<50	27.56
13	12/04/1989	UST Removal	1990	130,000	8/8/1997	130,000	8/6/1998	6,600	1,040	55,000	2,270	7.75
9	01/05/1989	GW Investigation	1990	120,000	4/3/1997	40,000	4/12/1999	9,100	590	140,000	16,000	21.71
18	02/06/1985	UST Removal	1990	73,000	6/1/1998	44,000	3/23/1999	13,000	8,000	120,000	110,000	34.15
12	02/09/1988	GW Investigation	1990	69,000	2/12/1996	24,000	8/18/1998	6,900	33	180,000	2,200	7.92

UST Removal = Discovered during removal of former USTs and/or piping

GW Investigation = Discovered during groundwater investigation not associated with a release (i.e. property transaction, leak detection, well installation, etc.)

Nuisance = Discovered due to off-site gasoline related nuisance conditions (i.e. vapors and water well impact)

Leak Detection Equipment = Discovered by UST system integrity test, leak detection monitoring equipment, other method

Table 4: Summary of UST System Information for Selected Study Sites

Site No.	UST Construction		Date UST Installed	Piping Construction		Date Piping Installed	Dispenser Pans(Y/N)	Spill/Overfill Protection (Y/N)	Monitoring Problems/ Violations	Integrity Test(P/F	Test Date	Recent Detailed UST Inspection?
1	FG	SW	1/1/1985	FG	DW	11/16/1995	Unknown	Y	None	P	1/12/1996	No
11	FG	DW	12/1/1985	FG	LT	12/1/1985	N	Y	None	P	5/30/1996	Yes: 3rd Party
7	FG	DW	1/1/1986	FG	LT	1/1/1986	N	Y	Y: Dispenser leak not detected and water in trenches	P (piping)	4/2/1998	Yes: Adv. Panel
2	ST	DW	1/1/1987	FG	DW	1/1/1987	Y	Y	Y: Raised Probe	F	7/21/1995	No
28	FG	DW	1/1/1986	FG	LT	Unknown	N	N	Y: Not operating	P	1/1/1994	No
29	FG	DW	4/1/1988	FG	LT	4/1/1988	Unknown	Y/N	Y: Trench not properly monitored	P (piping)	7/10/1996	Yes: Adv. Panel
22	FG	DW	11/1/1987	FG	DW	1/1/1987	Y	Y	None	P	3/1/1997	Yes: 3rd Party
3	FG	DW	1/1/1989	FG	DW	1/1/1989		Y	Y: Probes out of order	P	1/1/1989	No
10	FG	DW	1/1/1991	FG	DW	1/1/1991	Y	Y	None	P	2/21/1996	Yes: 3rd Party
8	FG	DW	11/1/1988	FG	DW	10/27/1986	N	Unknown	Unknown	None	N/A	No

Site No.	UST Construction		Date UST Installed	Piping Construction		Date Piping Installed	Dispenser Pans(Y/N)	Spill/Overfill Protection (Y/N)	Monitoring Problems/ Violations	Integrity Test(P/F	Test Date	Recent Detailed UST Inspection?
5	FG	DW	1/1/1991	FRP	DW	1/1/1991	Y	Y	None	P	4/3/1997	No
6	FG	DW	1/1/1990	FG	DW	11/9/1994	Y	Y	Y: System in alarm & product in sump.	P	3/22/1998	Yes: Adv. Panel and 3rd Party
13	FRP Clad ST	DW	12/1/1989	FG	DW	12/1/1989	Y	Y	None	P	1/1/1995	Yes: Adv. Panel
9	FG	SW	1/1/1983	FG	LT	5/1/1990	N	Y/N	Y: Leak Detection failures, water in sumps in trenches, system in alarm	P	9/12/1996	Yes: Adv. Panel
18	ST	DW	1/2/1990	FG	LT	3/26/1990	Y	Y	Y: Probes not functioning	P	4/25/1996	Yes: Adv. Panel
12	FG	DW	1/1/1989	FG	DW	1/1/1989	Unknown	Y	Y: Water in Interstitial Tank and sumps	P	5/18/1997	No

DW = Double Wall; SW = Single Wall; FG = Fiberglass; FRP = Fiberglass Reinforced Plastic; ST = Steel; LT = Lined Trench (SW piping)

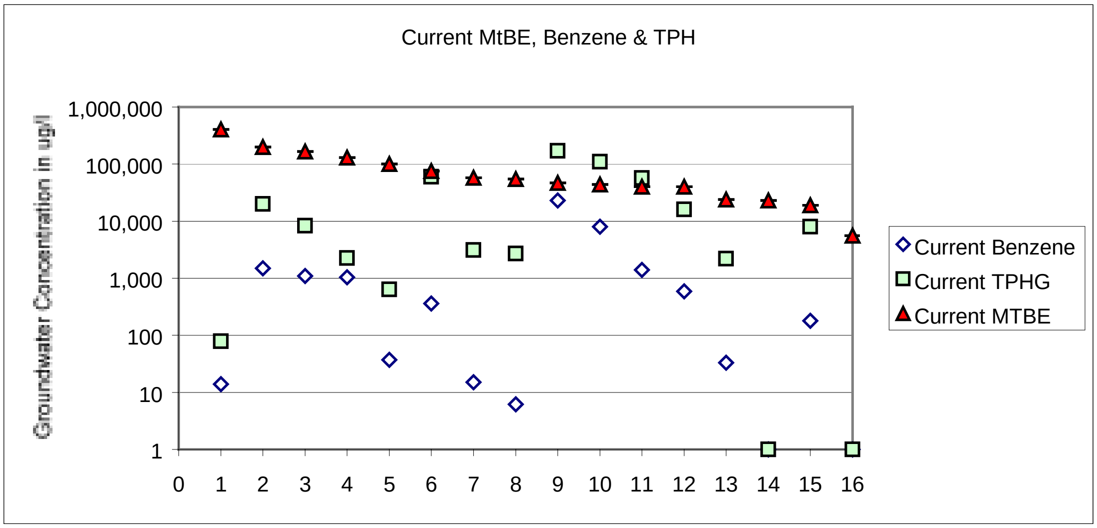
3.0 CASE STUDY RESULTS

The case study results are based on information obtained from UST and LUST files, quarterly groundwater monitoring reports, recent subsurface investigation results, and in some cases UST inspections or contaminant modeling, for 16 LUST sites within Santa Clara County. These sites were reviewed to evaluate whether high or increasing MtBE concentrations in groundwater may be attributed to undetected or ongoing releases from the current operating UST system. To assess the timing of the MtBE release for a particular site, all of the above information was considered along with relative gasoline constituent concentrations, distribution, and trends (i.e., TPHG vs. Benzene vs. MtBE) in groundwater. Isoconcentration contours for gasoline constituents in groundwater, soil contamination data (when available), and UST release/operation history were reviewed to identify potential source/ release areas of the UST system. To evaluate whether an undetected release was likely to have occurred, available data was reviewed in an attempt to identify the most reasonable release scenario.

3.1. EVALUATION OF MtBE VERSES BENZENE AND TPHG CONCENTRATIONS AND TRENDS

Relative concentrations of MtBE, Benzene, and TPHG in groundwater were compared for the 16 study sites (see Table 3). In addition, general trends of TPHG and MtBE were compared (see Table 6). The historic maximum MtBE concentrations ranged from 69,000 to 430,000 µg/L, while the current (most recent) concentrations of MtBE ranged from 5,600 to 405,000 µg/L. The range of current Benzene concentrations ranges from not detected to 23,000 µg/L. Ten of the 16 sites have Benzene concentration below 600 µg/L and seven sites below 100 µg/L. Current TPHG concentrations ranged from nondetect to 170,000 µg/L. Nine of the sites have current concentration of TPHG less than 10,000 µg/L. A scatter plot of the relative concentrations for each site is presented in Figure 1 below.

Figure 1. Comparison of Current MtBE, Benzene, and TPHG Concentrations in Groundwater at Each Site (µg/L)



As shown in Table 3 and Figure 1, two sites have current TPHG and Benzene concentrations below the detection limit. Conversely, there are only three sites with TPHG concentrations above the current MtBE concentration. For most of the sites (10), the TPHG concentration is at least 10 times less than the corresponding MtBE concentration.

Review of concentration trends at the study sites also show increasing MtBE concentrations. Fourteen of the 16 sites have or have had an increasing MtBE trend, and half (7) of the 14 sites with increasing trends exhibited an increase in MtBE concentration by 2 or more orders of magnitude from the original MtBE analyses (generally within two years). In comparison, only 5 study sites have increasing TPHG trends and with the exception of one of these sites, the current TPHG concentration is approximately an order of magnitude less than the historical maximum TPHG concentration. The differences in contaminant trends and date of historic maximum concentrations indicate that different releases have occurred.

3.2. SUMMARY OF REPORTED OXYGENATES

Ten of the 16 sites in the study had performed analyses for other oxygenates: Di-Isopropyl Ether (DIPE), Tertiary Amyl Methyl Ether (TAME), tert-Butyl Alcohol (TBA), and Ethyl tert-Butyl Ether (ETBE). TAME and TBA detections were the most significant. TAME is a relatively newer oxygenate addition to fuel, may be evidence of a more recent release. However, TAME can also be present as an impurity in gasoline. TBA is known to be an impurity in oxygenated fuel, but is also present as an additive and is a degradation breakdown product of MtBE. The relative concentrations of MtBE, TAME, ETBE, TBA, and DIPE for the 10 sites are presented in Table 5. In addition, the most recent Benzene concentrations are shown for comparison purposes.

Table 5: Oxygenate and Benzene Data in Groundwater for Study Sites

Historic High MtBE	Current MtBE	TAME	ETBE	TBA	DIPE	Benzene
430,000	75,500	**27**	**26**	<500	<10	150
405,000	405,000	<2,200	<2,200	**160,000**	<2,200	<100
280,000	167,000	<3,300	<3,300	<170,000	<2	2,300
200,000	200,000	**100**	<10	**3,600**	<10	3,200
170,000	23,000	<2	<2	<100	<2	3.4
140,000	58,000	<3,300	<3,300	<170,000	<3,300	30
140,000	54,800	<2	<2	<100	<2	<100
130,000	130,000	<2	<2	<100	<2	5,000
110,000	100,000	<500	<500	<10,000	<500	<12
73,000	44,000	**4.9**	<2	**290**	<2	9,900

(*Negative* values were not detected at the respective detection limit. Positive Oxygenate detections are bolded. All results in µg/L.)

3.3. POTENTIAL RELEASE SCENARIOS SUMMARY

The primary objective of this study was to evaluate the sites for potential release scenarios that could result in high or increased MtBE concentrations, in particular an undetected release. This section describes some of the possible scenarios which might be expected and which of these possible scenarios could be supported by the case studies. The scenarios fall under three general sections: 1) MtBE is associated with a previously reported known release, 2) MtBE is associated with a recent release not detected by the UST leak detection monitoring system, or 3) MtBE is not associated with a UST system release, i.e. surface spills. The section below describes these possible scenarios and is followed by case study results.

3.3.1. MtBE from Past Known Release

One potential source of high or increasing MtBE concentrations at LUST sites could be the previously reported known release prior to UST upgrades or replacement. This scenario was ruled out for most of the selected study sites. The site selection process was designed to select sites where the previous known release is not likely the cause of the significant MtBE contamination. In this study 13 of 16 sites had not reported a release since 1989 and most had subsequently replaced or upgraded the

UST system. For these sites the former known release would not be expected to be associated with increasing MtBE concentrations seen up to 10 years later.

3.3.2. MtBE from Undetected Release of Gasoline

Some possible scenarios for undetected releases from USTs are described below.

- Liquid product escaping at low volumes (for example: <0.1 gallons per hour or less than piping leak detection threshold) and not being detected by monitoring systems or integrity tests. Some of the possible low volume release locations can be summarized as follows.

    - Releases under dispensers without dispenser containment
    - Releases at piping connections
    - Releases at turbine sumps
    - Releases from overfill/spills

    The first three locations were identified as problem areas in the “Upgraded UST Release Site Evaluation Case Studies (UST Team 2 Report)”, (State Water Resources Control Board, 1999, UST Team 2). In addition, many of the sites reviewed in this study appeared to be lacking adequate dispenser containment and STP sumps. All of these areas were identified as problems in the “Survey of Current UST Management Operation Practices” (Alpine, 1999).

- MtBE/Fuel Releases Undetected Due to Improper Use or Failure of Monitoring Systems. Improper use, failure, and disabling of monitoring devices have been well documented as a significant mechanism in unauthorized releases (State Water Resources Control Board, 1999, UST Team 2) (Alpine, 1999). Many of the sites in this detailed case study had observations of monitoring problems or violations.

- MtBE escaping from UST systems as vapor. It is possible that groundwater could be contaminated by vapor releases; orders of magnitude greater than corresponding concentrations of BTEX and TPH and possibly other oxygenates. The following are potential causes of vapor releases:

    - MtBE vapor leaking out of bad seals and gaskets or inappropriately sealed penetrations in various portions of the UST system.
    - MtBE vapor leaking out of small holes, drain valves, or other components due to excessive pressurization of the tank by use of ball float vent valve (State Water Resources Control Board, LG150), tank filling or pressure testing (Alpine, 1999).

- MtBE vapor leaking due to potential incompatibly and/or permeation of high concentrations of MtBE in vapor. Current resins in fiberglass are considered compatible with MtBE up to 20 percent by volume. If vapors had a higher concentration of MtBE, this compatibility may not be present.

3.3.3. MtBE infiltration from wash down or infiltration of surface spills

- Theoretically surface spills can become a groundwater quality problem, particularly when dealing with chemicals with a relatively high solubility. Spills can transport to the subsurface through poor asphalt surfaces, cracks or joints in cements surfaces, improperly sealed conduits (i.e. monitoring wells), and leaky sewers. A study recently conducted to estimate groundwater impacts from surface spills indicates that the resultant groundwater impact would be minimal (<11µg/L) in the scenarios modeled (Malcom Pirnie, Inc, September 1999). However, in cases such as immediate transport of a spill through a conduit, the resultant impact would be expected to be more significant. Even given a scenario of immediate transport, the magnitude of MtBE concentrations and increasing contaminant concentrations seen in this study are not expected to be associated with this release mechanism.

3.4. RESULTS OF CASE STUDY EVALUATIONS OF RELEASE SCENARIOS

As stated, the general release scenarios evaluated fall under three general sections: 1) MtBE is associated with a past known release, 2) MtBE is associated with a recent release not detected by the UST monitoring system, or 3) MtBE is not associated with a UST system release, i.e. surface spills. This section describes the results of the evaluations to identify possible undetected releases and potential release scenarios.

3.4.1. Evaluation of Undetected Releases

Based on a subjective evaluation, 15 of the 16 sites are suspected of having had an undetected (either recent or ongoing) release; 13 from the current UST system. The evaluation was made based on all the available information in an effort to determine whether the significant MtBE contaminant concentrations at these sites were a result of past known releases, or a result of undetected releases from the current UST system. The degree of certainty regarding the conclusions varies, but in general, an undetected recent release is the most reasonable explanation of the high and recently increased MtBE concentrations at the majority of these sites. The site-specific summaries in Section 7.0 discuss in more detail the information used in the evaluation and the information is summarized in Table 7.

3.4.2. Summary of Potential Undetected Release Scenarios

A summary of the individual suspected release scenarios is presented in Table 6 and a more detailed discussion follows.

Table 6: Results of Release Scenario Evaluation

Release Scenario	Number of Sites Confirmed	Number of Sites Suspected
Low Volume Release	-	8
-Dispenser not contained	-	3
-Piping Connections	-	-
-STP Sumps	1	5
-Overfill/overspill	-	-
Inadequate Monitoring Equipment	1	4
Vapor phase Releases	1	2

[Note: Some sites had more than one plausible release scenario, while other sites had inconclusive results]

The release location at two of the sites has been confirmed. In one case, a leak in the primary piping drained to the STP sump but was not contained or detected in the sump (Site No. 2). In the other case, the owner has identified the release mechanism as a vapor release that was related to the vapor recovery system and potential breaches in various portions of the system (Site No. 6).

Two sites that conducted detailed testing of secondary containment portions of the system found that dispenser pans and STP sumps were not liquid tight (Sites No. 10 & 22), but a release from these components was not verified.

Several sites had monitoring problems that may have resulted in a low volume release not being detected by the leak detection equipment.

Other than the confirmed vapor release referenced above, there were only two sites in the study that appeared likely to have vapor phase issues. In one case the interstitial space vapor between the tank walls was measured at a 30 percent lower explosive limit (LEL). In the other case, a 100 percent LEL was measured in the interstitial space of the tank. The source of the vapors was not determined.

3.5. SOURCE LOCATION EVALUATIONS

An attempt was made to determine the potential release location or release scenario for each site. This evaluation was complicated by a number of factors, including: inadequate number of well locations close to potential sources, close proximity of individual system components to one another, inability to distinguish piping or dispenser problems which could drain to the tank complex, inability to distinguish between piping and dispensers as potential sources, and the lack of site inspection for many of the sites. For six sites, this evaluation was aided by information gained from detailed facility inspections performed by third party contractor or routine regulatory agency site inspections. Six of these sites were included in the Governor's UST/MtBE Advisory Panel study and were inspected by the members of the panel. The following is a brief summary of suspected source areas. This information is also presented in Table 7.

- Twelve of the sites appeared to have source locations around the tank complex. Five of these are suspected of having releases associated with inadequate or absent sumps around STP.
- Two sites appeared to have problems associated with the lined trenches
- Two sites appeared to have source areas located around the tanks and piping
- Three sites appeared to have source areas near the piping/dispenser
- One site had inconclusive data

[Note: some sites had more than one plausible source location]

3.6. OPERATIONAL OBSERVATIONS

At least 9 of the 16 cases had notices of violation or problems noted by the local agency inspector or Governor's Advisory Panel related to monitoring system components. Four sites had performed third party inspections which resulted in finding components that were either not liquid tight or not vapor tight. There were 3 facilities that did not have detailed inspection records available and did not have any violations noted in the UST file records.

Table 7: Summary of Study Sites 1

Site No.	High MTBE	Date	Current MTBE	Date	Overall MtBE Trend	Date Release Reported	UST	Date UST Installed	Piping	Date Piping Installed	Dispenser Pans(Y/N)	Spill/Overfill Protection (Y/N)	Review Notes	Potential Source Areas	Suspect Undetected Release	Suspected Release Scenario	Monitoring Problems/ Violations
1	430,000	3/5/1997	75,500	5/11/1999	Increasing Trend: 22,000 ug/l - 1994 430,000 ug/l- 3/97 Decreasing since recent upgrade work	02/02/1993	SW	1/1/1985	DW	11/16/1995	Unknown	Y	Pump islands are a potential source area. Also, isoconcentration contours depict tank cavity as a potential source area. Release may have been stopped when piping replaced in 1995. May not be post-upgrade release, but the release was not detected by the UST leak detection system	Tanks or dispenser	Yes	Inconclusive	None
11	405,000	7/29/1999	405,000	7/29/1999	Increasing Trend: 130 ug/l - 3/96 405,000 ug/l - 5/99	12/04/1986	DW	12/1/1985	LT	12/1/1985	N	Y	Performed multi-system check. Everything appears in order. Need turbine sumps & dispenser pans. Loose vapor fitting on #5. Gaskets on fill for Plus are torn. Drain knob and support missing, valve R&R.) Release appears post-upgrade, likely related to lack of secondary containment around STP and piping.	Inconclusive, but dispensers and STP not secondarily contained.	Yes	Possibly low level release not contained or detected at sumps or dispensers	None
7	280,000	4/6/1998	167,000	1/7/1999	Increasing Trend: 48,000 ug/l - 7/96 280,000 ug/l - 4/98	02/12/1986	DW	1/1/1986	LT	1/1/1986	N	Y	Piping in trench. Sump is corrugated metal. Inspection revealed leak at dispenser and problems with piping trench. Increasing benzene and TPH since 1994 and 1993, respectively. MtBE off site, not Petroleum hydrocarbons. Suspect post-upgrade release	Leak at dispenser and possibly draining to sump, but not contained	Yes	Low level release at dispenser or piping areas not secondarily contained (sumps/ dispensers)	Y: Dispenser leak not detected and water in trenches
2	260,000	1/30/1997	47,000	5/10/1999	Decreasing	07/17/1995	DW	1/1/1987	DW	1/1/1987	Y	Y	Primary piping release into interstitial piping to STP sump. Sump did not contain product and system never went into alarm. Release stopped in 1994 when piping was replaced. Confirmed release from 1998 compliant system.	Leak in primary piping not contained or detected in sump	Yes	Failed primary piping, secondary containment and monitoring at sump	Y: Raised Probe

Site No.	High MTBE	Date	Current MTBE	Date	Overall MtBE Trend	Date Release Reported	UST	Date UST Installed	Piping	Date Piping Installed	Dispenser Pans(Y/N)	Spill/Overfill Protection (Y/N)	Review Notes	Potential Source Areas	Suspect Undetected Release	Suspected Release Scenario	Monitoring Problems/ Violations
28	210,000	2/9/1999	19,000	5/4/1999	Increasing Trend: 6400 ppb 9/95 25,000 ppb 10/97 210,000 ppb 2/99	06/18/1986	DW	1/1/1986	LT	Unknown	N	N	Monitoring violations in 1990. UST system may need dispenser pans and overfill buckets. The MtBE contaminant data depicts the location of the USTs as the most likely source location. In 1996 however, the highest MtBE concentration was detected in MW-3 closer to the dispensers. The current MtBE contours coupled with the accumulation of free product in MW-4 in 1993 indicates that the tank area is a more likely source area and appears to be a post upgrade release.	Tank pit area most suspect.	Yes	Release not detected, possibly due to non-operable leak detection system	Y: Monitoring system not operable on 2 occasions
29	200,000	6/9/1999	200,000	6/9/1999	Increasing Trend: 980 ug/l - 1/96 200,000 ug/l - 6/99	01/08/1986	DW	4/1/1988	LT	4/1/1988	Unknown	Y/N	Isoconcentration contours from old release depict pump islands as potential source area. MtBE contours depict tank area as most likely source. Problems with monitoring in lined trench and vapor in interstitial tank space. Suspect post-upgrade release.	Tank pits area most suspect.	Yes	Possibly small leak draining to sump or vapor related issue. 30% LEL detected in interstitial space of UST. May also relate to inadequate lined trench monitoring.	Y: Trench not properly monitored
22	170,000	9/16/1998	23,000	3/10/1999	Increasing Trend 10,000 ug/l -12/96 170,000 ug/l - 9/98, decreasing in 1999	01/20/1988	DW	11/1/1987	DW	1/1/1987	Y	Y	Suspect new tank area as source. New tanks since 87. Isoconcentration contours depict new USTs as source. Lake tests performed on 4/98.Dispenser Pans and STP sumps failed and repaired. Suspect post-upgrade release in new tank area.	Tank pit area most suspect.	Yes	Possibly low level release not contained at sump.	None

Site No.	High MTBE	Date	Current MTBE	Date	Overall MtBE Trend	Date Release Reported	UST	Date UST Installed	Piping	Date Piping Installed	Dispenser Pans(Y/N)	Spill/Overfill Protection (Y/N)	Review Notes	Potential Source Areas	Suspect Undetected Release	Suspected Release Scenario	Monitoring Problems/ Violations
3	120,000	3/7/1997	40,000	12/9/1998	Increasing Trend: 1000 ppb 2/96 170,000 ppb 3/97	02/01/1988	DW	1/1/1989	DW	1/1/1989		Y	Significant increases in concentrations and migration. Isoconcentration contours depict tank system or piping as most probable source. Probes out of order on two inspections. Highest concentrations 160 feet downgradient 11/97.	Tanks/piping (maybe sump)	Yes	Possibly low level release, maybe associated with poor monitoring.	Y: Probes out of order
10	110,000	5/7/1998	100,000	8/28/1998	Increasing Trend: 18 ug/l - 7/95 110,000 ug/l -12/96	06/30/1988	DW	1/1/1991	DW	1/1/1991	Y	Y	DW system in 1991. Significant increase in tank well MW-8 (13 in 7/95 to 110,000 in 4/97, 14,000 '98, 100,000 '99) 12/97 vapor and lake tests. Leaks in pans, secondary boot, and STP sump. Maybe temporary release; now stopped. However, recent MtBE increases observed. Suspect post-upgrade release.	Sump end of USTs	Yes	Possibly small leak draining to sump.	None
8	140,000	12/19/1996	58,000	5/6/1999	No trend: Slight Increase: 99,000 ug/l - 5/96 140,000 ug/l - 5/98 then decrease to 58,000	10/15/1986	DW	11/1/1988	DW	10/27/1986	N	Unknown	Lines or dispenser most suspect. Highest groundwater and soil concentrations nearest piping/dispensers. Varying concentration in MW-2, Highest in 2/97. DG of tanks (MW-1) not as high as MW-4. Piping and tanks DW since '86 & '88. Appears to be post-replacement release but some components recently upgraded.	Piping/ Dispensers	Yes	Low level release at or near dispensers/ piping not detected by the UST leak detection system.	Unknown
5	140,000	2/23/1998	54,800	6/16/1999	Increasing Trend 170 ug/l - 8/95 140,000 ug/l -11/96 then decrease, still above 50,000 ug/l	12/16/1983	DW	1/1/1991	DW	1/1/1991	Y	Y	Initially significant increase from 19 ppb in 1995 to 140,000 ppb in 11/96. Migration evident. Isoconcentration contours separate the old TPH plume from new MtBE plume. Tank fill/vent line connection is suspected as source area of post-upgrade release.	Tank fill area	Yes	Low level release not detected by the leak detection system.	None

Site No.	High MTBE	Date	Current MTBE	Date	Overall MtBE Trend	Date Release Reported	UST	Date UST Installed	Piping	Date Piping Installed	Dispenser Pans(Y/N)	Spill/Overfill Protection (Y/N)	Review Notes	Potential Source Areas	Suspect Undetected Release	Suspected Release Scenario	Monitoring Problems/ Violations
6	140,000	7/6/1999	5,600	7/6/1999	Decreasing	01/20/1998	DW	1/1/1990	DW	11/9/1994	Y	Y	Original LUST case closed in 1991. MtBE contamination detected during 1998 investigation associated with municipal well contamination. Release appears to be post-upgrade and UST system inspections reveal vapor release as most likely scenario.	Tank pit area most suspect.	Yes	Vapor Release	Y: System in alarm & product in sump.
13	130,000	8/8/1997	130,000	8/6/1998	Increasing Trend: 290 ug/l - 3/96 to 130,000 ug/l - 7/99	12/04/1989	DW	12/1/1989	DW	12/1/1989	Y	Y	Leak detection equipment passed in '97. '95 positive shut down not working. 1998 inspection good except for product and raised probe in sump. Highest MtBE downgradient of tanks. Highest TPH/B upgradient of tanks. Increasing MtBE. Appears to be post-upgrade release.	Tanks/piping	Yes	Inconclusive, but 100% LEL in interstitial space. Could have vapor breach.	Y: Product in sump and probe raised
9	120,000	4/3/1997	40,000	4/12/1999	Increasing Trend to 1997. Depends on well. 10,000 ug/l - 11/95, 120,000 ug/l - 8/97, 12,000 ug/l - 5/99	01/05/1989	SW	1/1/1983	LT	5/1/1990	N	Y/N	Reported problems with Red Jacket leak detection equipment and water intrusion in sumps and trenches. Retrofitted with STP sumps and dispenser pans in 1998. Highest concentration is downgradient of tanks. Release mechanism unclear but could be related to trench/sump problems. May have been stopped during recent upgrade work (not required by upgrade regulations). Recent decreases in MtBE in source well may be due to upgrade work.	Tank pit area most suspect.	Yes	Inconclusive, but likely ongoing small release not contained or detected (Sumps/ piping). Possibly related to monitoring problems	Y: Leak Detection failures, water in sumps in trenches, system in alarm
18	73,000	6/1/1998	44,000	3/23/1999	Slight Increase	02/06/1985	DW	1/2/1990	LT	3/26/1990	Y	Y	Problems noted with leak detection equipment in 93 and 96; OK as of 10/96. Inspection in 1998 revealed leaking dispenser and sumps were not properly sealed. Source area investigation did not reveal evidence of new release. Increasing MtBE is only evidence of recent release. Inconclusive data to conclude a post upgrade release.	Fill end of USTs	Inconclusive	Potential for undetected release due to monitoring problems.	Y: Probes not functioning

Site No.	High MTBE	Date	Current MTBE	Date	Overall MtBE Trend	Date Release Reported	UST	Date UST Installed	Piping	Date Piping Installed	Dispenser Pans(Y/N)	Spill/Overfill Protection (Y/N)	Review Notes	Potential Source Areas	Suspect Undetected Release	Suspected Release Scenario	Monitoring Problems/ Violations
12	69,000	2/12/1996	24,000	8/18/1998	Increase/Decrease Depends on well 530 ug/l - 11/95 69,000 ug/l - 2/96 12,000 ug/l - 9/96	02/09/1988	DW	1/1/1989	DW	1/1/1989	Unknown	Y	Water inflow to interstitial space in Plus tank (date unknown). Tank needs repair. Other violations/alarms. Significant migration, MtBE increases correlate with date of observed problems. Isoconcentration contours show tank location most suspect (Premium tank). Suspect post-upgrade release.	Tank Complex	Yes	Suspect low level release associated with sump and interstitial space problems	Y: Water in Interstitial Tank and sumps

4.0. FINDINGS

This section presents a summary of case study findings related to MtBE concentrations and trends, potential release areas and scenarios, and UST system operations and components.

4.1. FINDINGS RELATED TO MtBE CONCENTRATIONS AND CONTAMINANT TRENDS

The 16 individual cases selected for this study were reviewed for increasing or increased MtBE concentrations. Table 7 includes a summary of the MtBE trends. The case summaries in Section 7 include graphs for MtBE concentrations over time for the source area wells at each site and a more detailed discussion of the TPHG and MtBE concentration trends at the site. The following is a summary of findings of the MtBE concentration and contaminant trend analysis for the 16 sites studied.

- Fourteen of the 16 sites have had a maximum concentration of MtBE over 100,00 µg/L MtBE.

- Fourteen of the 16 (88 percent) sites have or have had an increasing MtBE trend during the period of 1996 to 1999. The two cases with consistently decreasing MtBE trends have active remediation systems operating and have isolated the suspected new release location and abated the leak.

- Two other cases that initially had increasing trends but more recently exhibited a decreased trend are also suspected of abating a more recent release.

- Seven of the 14 sites with increasing trends exhibited an increase in MtBE concentration by 2 or more orders of magnitude from the original MtBE analyses. Two of the 14 sites had increases by approximately four orders of magnitude (for example: from 18 µg/L in 1995 to 110,000 µg/L in 1998). Both of these sites had initial MtBE concentrations of less than 50 µg/L.

- Of the 14 sites that have had increasing concentrations, 3 are currently at all time high MtBE concentrations. The other 11 sites have current MtBE concentrations below the all time high. Some of the 11 sites are exhibiting fluctuating concentrations and may increase again, while others appear to have reversing trends (now decreasing).

- All of the sites that have had increasing trends of MtBE were cases where the original release was reported prior to 1990 and the tanks and piping were replaced prior to 1992.

4.2. FINDINGS RELATIVE TO UNDETECTED RELEASES

- Fifteen of the 16 LUST case study sites are suspected of having had an undetected release that resulted in the high or increasing MtBE concentrations. Thirteen of the 16 case study LUST sites are suspected of having had an undetected release from the current UST system. The degree of certainty regarding the conclusions varies, but in general, an undetected recent release is the most reasonable explanation of the high and recently increased MtBE concentrations at the majority of these sites.

- Two of the sites with significant MtBE plumes were verified as having had an undetected release from the current UST system. The releases were only discovered to have had a release because of significant nuisance conditions that warranted investigation. In one case, vapors in an off-site sewer prompted investigation of the USTs. The investigation found that a significant release of fuel occurred but was not contained or detected by the UST monitoring system. In the other case, detection of MtBE in a nearby municipal well prompted investigation of the site where a significant MtBE plume was detected.

4.3. FINDINGS RELATIVE TO POTENTIAL RELEASE SCENARIOS

- The release locations for 2 of the 16 sites have been confirmed. In one case, a leak in the primary piping drained to the STP sump but was not contained or detected. In the other case, the owner has identified the release mechanism as a vapor release that was related to the vapor recovery system and potential breaches in various portions of the system.

- Two sites that conducted detailed testing of secondary containment portions of the system found that dispenser pans and STP sumps were not liquid tight.

- Sites where MtBE in groundwater may have resulted from the known release prior to UST upgrades were generally not considered for this study and do not appear to be the release scenario for the study sites. However, at one site the release may be attributed to a pre-upgrade release (Site 1).

- Liquid product escaping at low volumes (<0.01 gallons per hour) and not being detected by monitoring systems or integrity tests is a scenario that would best apply to release points not secondarily contained. At least 8 sites in this study may have releases attributed to this scenario.

- MtBE escaping as vapor from UST systems is a plausible release scenario theoretically. It has not been rigorously examined, but is a documented release scenario in one case examined in this study and may be a potential concern at two other sites.

- MtBE infiltration from wash down or infiltration of surface spills is not considered to be a release scenario for any of the cases in this study. However, there are scenarios where surface spills can result in water quality degradation.

4.4. FINDINGS RELATIVE TO POTENTIAL SOURCE LOCATIONS

- Twelve sites appeared to have at least one source location around the tank complex. Five of these are suspected of having releases associated with inadequate or absent sumps around STPs.

- Three sites appeared to have a potential source location near or associated with the dispensers.

- Four sites appeared to have potential source locations near or associated with the product piping.

  [Some sites had more than one likely source location]

4.5. FINDINGS RELATIVE TO UST SYSTEM COMPONENTS, OPERATIONS, AND INSPECTION OBSERVATIONS

- Of the 7 sites with double-walled tanks and piping, dispenser pans and overspill/overfill prevention components, 3 were found to have sumps that were not liquid tight and a fourth site had components that were not vapor tight.

- Four sites in all, had performed third party inspections which resulted in finding components that were either not liquid tight or not vapor tight.

- Of the 6 sites with lined trench piping, five were noted to have monitoring violations or monitoring problems or water infiltration problems (2 sites).

- At least 9 of the 16 sites had notices of violation or problems noted by the inspector or UST Advisory Panel related to monitoring system components.

- Three sites had observations of water and/or product in the sumps

- Thirteen of the 16 sites had the UST system or piping integrity tested since 1995. All but one passed the integrity test.

5.0 CONCLUSIONS

The results of this study show that new or upgraded USTs do not afford 100 percent protection against fuel releases and UST monitoring systems are not necessarily effective in detecting releases, even for those sites which appear well maintained and operated. The results of the detailed LUST case study discussed in this report and the District's MtBE and UST Pilot Study indicate that for these recent and undetected releases, MtBE is the most significant fuel constituent detected in groundwater.

Review of overall groundwater data reported for operating gasoline facilities in Santa Clara County indicates a disturbing rate of occurrence and magnitude of MtBE in groundwater compared to sites no longer storing or dispensing fuel. The results of the detailed LUST case studies reveals that significantly increasing MtBE contaminant trends appear to be the result of undetected releases from new or upgraded UST systems. It is important to note that these high levels of MtBE contamination would not have been detected if environmental investigation or monitoring had not been conducted as part of a previous investigation and cleanup directives. The exception was for two cases where the MtBE contamination was only discovered due to nuisance conditions (vapor in sewer and water well impact) that prompted investigation of the sites.

For 13 of the 16 study sites, the specific causes of MtBE contamination cannot be definitively determined, but an undetected release was judged to be the most reasonable scenario based on the case study review. Inadequate or lacking secondary containment and improper monitoring seem to be a common theme associated with suspected undetected MtBE releases. Even with detailed system inspections and component testing, the release mechanism often remains elusive. However, detailed analysis of site specific data and UST inspection and compliance information does help to resolve some questions regarding potential sources and/or timing of releases.

Results of this and similar studies referenced in this report indicate the need for increased vigilance in maintaining, operating and inspecting UST facilities. Overall, the release mechanisms for MtBE at most LUST sites with MtBE in groundwater are not well understood. Due to the potential for undetected releases to continue to occur, and the occurrence of undetected releases that have not been identified, groundwater resources will continue to be threatened by the continued use of MtBE, or similar additives in gasoline.

6.0 RECOMMENDATIONS

The results of this and similar studies should be used to assess the threat to water resources posed by storage of fuels in USTs and the operation of fueling facilities. The level of threat posed is also directly related to the chemical properties of the fuel constituents**. Common areas of weaknesses in UST systems exist and have been identified by this and similar studies. Resources should be directed to those areas that present the most significant threat to water resources**

Whereas most of the cases examined in this study had double-walled tanks and piping, **particular attention should be paid to single-walled tank and piping systems which have no protection against low volume leaks** that may not be detected by monitoring systems or integrity testing. Specific vigilance should be paid to these facilities. Conversely, **the mere presence of a double-walled UST system should not be considered guaranteed protection against undetected and/or significant releases.** It is imperative that secondary containment components are tested to determine if they are effective in containing and detecting leaks.

Fluctuating concentrations of MtBE in groundwater are observed at many operating LUST sites and can increase or decrease by orders of magnitude over a 1-year period. The reasons for such fluctuations are not clearly understood, and are seldom properly investigated or reported. The fluctuations observed at the study sites appear to be related to undetected releases at sites where UST are still present. **State and regional LUST program managers should carefully weigh the uncertainty associated with such reported groundwater monitoring data and consider the possibility of continuing releases prior to closing cases or in considering whether to re-open closed cases.** These considerations may include a review of facility management practices, appropriateness of existing groundwater monitoring well networks, release history, and underlying aquifer sensitivity the site.

The severity of MtBE contamination examined in this LUST population cannot be presumed to exist at all UST facilities. However, the District's Pilot Study of MtBE Occurrence Associated with Operating UST Systems found that minor to significant levels of MtBE contamination in groundwater can result from undetected releases at non-LUST sites and that MtBE could be present at up to 50 percent of the operating UST sites. This study found that high concentrations of MtBE contamination in groundwater appear to be the result of undetected releases at many sites. **To verify if undetected releases have occurred at non-LUST sites and to determine the level of MtBE contamination, environmental monitoring (in this instance sampling of groundwater) is necessary.** This should involve the collection of both soil and groundwater samples.

There is not currently a requirement for operating UST facilities to conduct environmental monitoring at non-LUST sites. Environmental monitoring should be considered the only method to confirm the presence of MtBE in groundwater and evaluate the threat that past and continuing undetected releases pose to groundwater resources. **The investigation of MtBE occurrence at all operating UST sites and gasoline stations should be a priority for any groundwater protection program in areas where MtBE or similar chemicals have been or are added to gasoline. In vulnerable groundwater areas the identification of these "undetected" MtBE groundwater plumes should be the foremost groundwater protection priority.**

7.0 SITE SPECIFIC SUMMARY SHEETS

SITE NUMBER 1

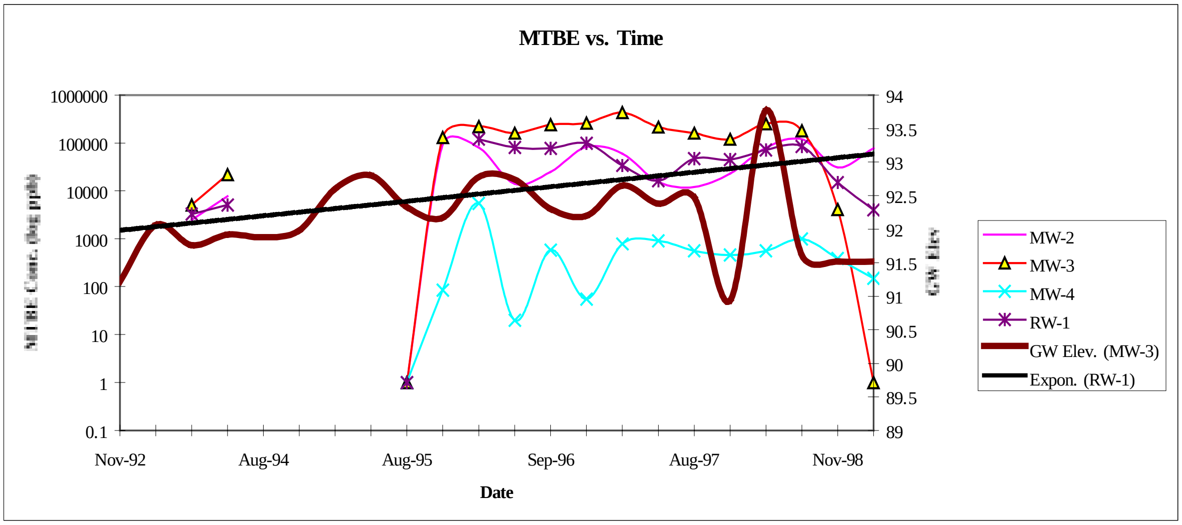
Fuel Leak History

Groundwater contamination was detected in 1992 when groundwater monitoring wells were installed. Discovery of the contamination led to a release reported on February 2, 1993. The piping was upgraded to double-walled in late 1995. Low concentrations of petroleum hydrocarbons were detected in the native soil beneath the piping. Staining was observed in soil near the dispensers. No other unauthorized releases have been reported.

MtBE Trend Analysis

Four groundwater monitoring wells were installed in 1992 and up to 3,700 µg/L TPHG and 1,900 µg/L Benzene were detected. The wells were installed as part of property divestment investigation. A release from the UST system had not been reported and the source of the contamination was unknown. TPHG concentrations significantly increased in 1994 and continued to increase until early 1998. Benzene concentrations remained with the historic high concentrations until 1995 when concentrations decreased significantly. Benzene has not been detected in most of the wells since 1997.

MtBE analyses began in 1993. Up to 22,000 µg/L was detected in 1994 when MtBE analyses temporarily ceased. MtBE analyses restarted on a quarterly basis in 1995. MtBE was not detected in any well in August 1995. By the next quarterly monitoring event several wells showed significant concentrations of MtBE, up to 130,000 µg/L. Concentrations of MtBE continued to increase in many of the wells until March 1997 when a high of 430,000 µg/L was detected. Concentrations have remained very high, with the exception of a decline in late 1998 in two of the source area wells.



UST System Information

One 10,000-gallon, one 8,000-gallon, and one 6,000-gallon single-walled fiberglass USTs were installed in 1985. The single-walled fiberglass piping was replaced by double-walled piping in November 1995. The tanks passed five integrity tests from 1990 to 1996. An August 1998 report indicates that the USTs have been shut down pending replacement.

Suspected Release Scenario

Groundwater analytical data indicates a generally increasing trend of TPHG and MtBE in RW-1, MW-2 and MW-3. The TPHG increases were most significant in 1994 and 1996. MtBE increases in concentrations in the same wells were most significant in 1995. The isoconcentration contours do not clearly indicate which portion of the system is the most suspect source area, but the tank cavity appears the most likely based on the concentration data from MW-2 (adjacent to tanks, 60-feet cross gradient from the dispensers). In addition, the responsible party stated in 1994 that the tank cavity appeared the most likely source of petroleum hydrocarbons. There were two periods where reduction in concentrations were observed, the most significant being TPHG and MtBE reductions in MW-3 and RW-1 three months after the USTs were shut down for replacement activities. Similar reductions in concentrations were not observed when the piping was replaced in 1995/96. From May 1998 to January 1999 concentrations of TPHG and MtBE in RW-1 declined from more than 50,000 µg/L to approximately 5,000 µg/L. For the same time period concentrations in MW-3 for TPHG and MtBE declined from 87,000 µg/L and 180,000 µg/L, respectively, to nondetectable for both constituents.

Conclusion

Since the contamination was discovered as part of a groundwater investigation it is clear that the release was not detected by the UST leak detection monitoring system. The timing of the release mechanism cannot be determined and may have been a pre-upgrade release. Based on the soil sample results from the piping replacement it appears that there was an unreported release near or beneath the dispensers. Based on the isoconcentration contours and contaminant trends it appears that there may have been a more significant and possibly ongoing release at the location of the USTs.

SITE NUMBER 11

Fuel Leak History

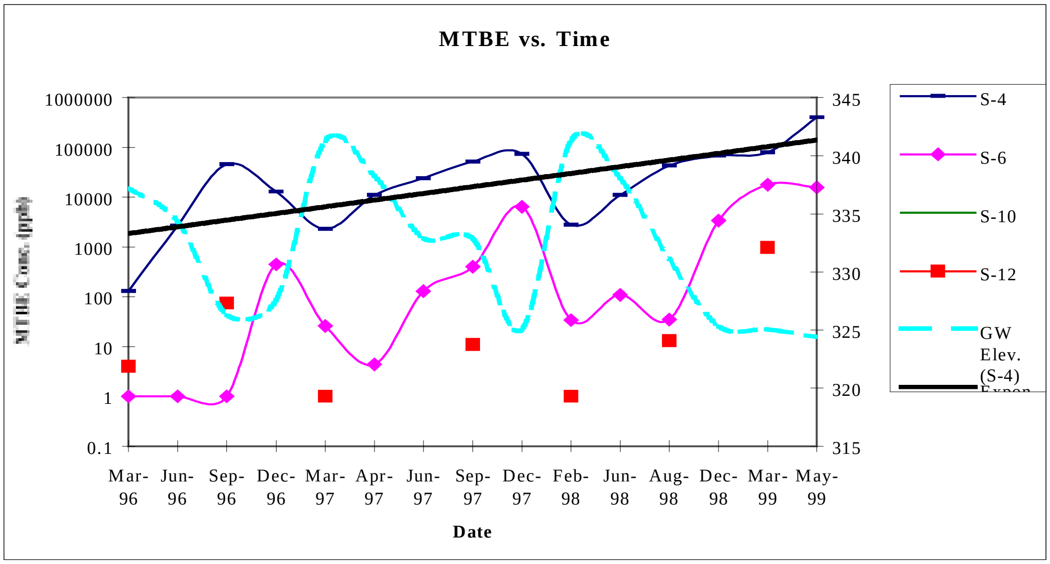
The first release was discovered in December 1985 when the former USTs and piping were removed. The USTs and piping were replaced with double-walled fiberglass and fibertrench lined piping, respectively.

No releases have been reported since the tanks were replaced.

MtBE Trend Analysis

Significant concentrations of dissolved TPHG were detected in groundwater from 1986 to 1988, when the source area monitoring well went dry. In 1993, groundwater monitoring was resumed and low to moderate levels were detected.

MtBE analyses began in March 1996. The highest concentration of MtBE detected in March 1996 was 130 µg/L. At this time the MtBE plume appeared relatively small and localized. MtBE concentrations increased by several orders of magnitude over the next few sampling events in the source well (S-4). Many sampling events have shown a decrease in MtBE concentrations by an order of magnitude. It is expected that MtBE concentrations will continue to fluctuate with groundwater elevation changes. It appears that the increasing groundwater elevation is causing either the residual pollution or the monitoring well screen to be submerged and resulting in decreased contaminant concentrations. The highest concentration of MtBE ever detected at this site was 405,000 µg/L in May 1999. There appears to be an inverse correlation between groundwater elevation and MtBE concentrations at this site. Increases in MtBE concentrations are also being seen in the downgradient well S-6. The 10,000 µg/L plume appears to extend more than 130 feet from the source.



UST System Information

Double-walled tanks and single-walled piping with fiberglass lined trenches were installed in December of 1985. Dispenser pans and containment around the pump turbines are planned.

Suspected Release Scenario

Due to the decreases in TPHG and Benzene concentrations, low volumes of MtBE used in this area before 1986, and increases in MtBE concentrations, it appears that the TPHG and MtBE plumes are unrelated and that the MtBE is not associated with the release reported and stopped in 1985. The isoconcentration contours do not depict a precise source location due to the monitoring well configuration and the close proximity of the pump islands and piping to the USTs. In addition, the UST system has been tested and inspected in both 1996 and 1997 with no evidence of a leak. During the most recent inspection a loose vapor fitting and torn fill gaskets were observed. Therefore, if a current release is responsible for the increases in MtBE, it is likely to be a leak rate too low to be detected by the testing, or is associated with those portions of the system not covered by the testing. Dispenser or submersible turbine pump areas are potentially responsible since they are not double contained at this time. The groundwater elevation and concentration correlations suggest that the release occurred while groundwater elevations were lower and that there may not be an ongoing release at the site.

Conclusion

Due to the increasing MtBE concentration from 1996 to 1999, decreasing TPHG concentrations, and the long time elapsed since the current UST system was installed, it appears that a release occurred and went undetected by the UST leak detection monitoring system.

SITE NUMBER 28

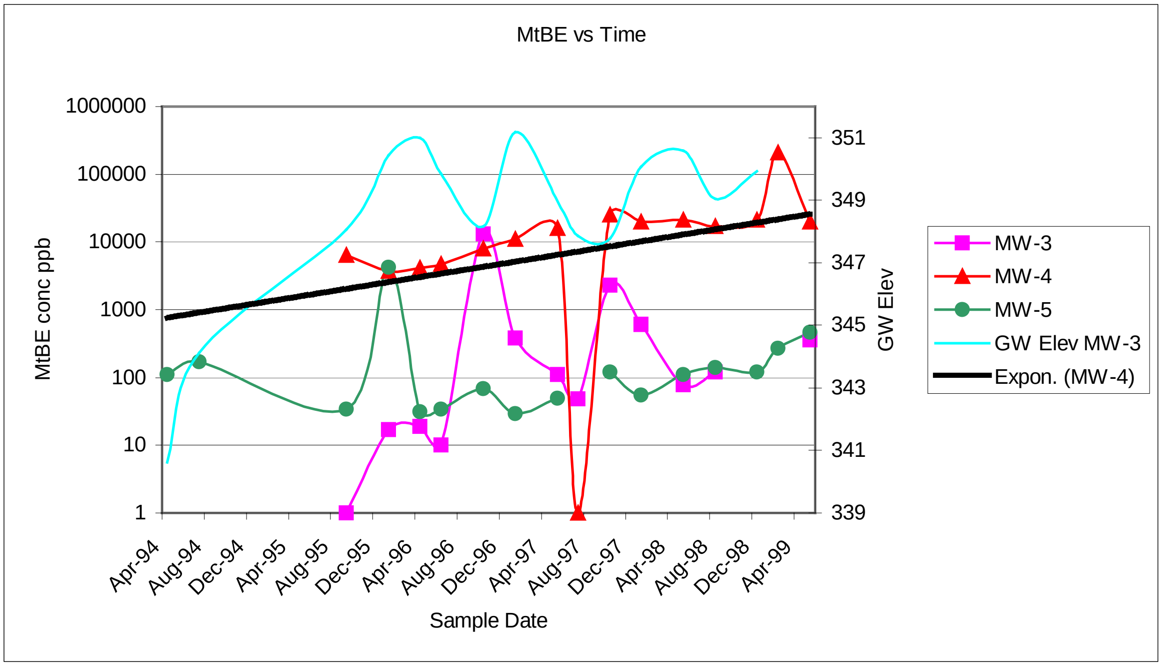
Fuel Leak History

A release was first detected and reported at this site in 1986 when contamination was discovered during UST system replacement. No other releases have been reported.

MtBE Trend Analysis

Quarterly groundwater monitoring began in 1990. The highest dissolved TPHG and Benzene concentrations were detected in 1991 at 34,000 µg/L and 2700 µg/L, respectively. Petroleum hydrocarbon concentrations in this well (MW-3) have declined dramatically. TPHG and Benzene concentrations have remained below 1,000 µg/L and 100 µg/L, respectively, since 1995. Conversely, TPHG and Benzene concentrations were below or just above detection limits in well MW-4 until 1992. In 1993, free product was observed in the well. Significant concentrations of dissolved TPHG and MtBE were detected in 1999.

MtBE analyses were first conducted at this site in 1993; 26 µg/L was detected in MW-1. Regular MtBE analyses began in 1995 for most sites associated monitoring wells with up to 6400 µg/L detected in MW-4. Concentrations have continued to increase in most of the source area wells. MtBE concentrations in MW-4 continued to increase up to 210,000 µg/L in February 1999.



UST System Information

According to agency records, one double-walled tank was installed in 1986 and two in 1988. It appears that the trench lined fiberglass piping was replaced within the same time frame. No other reports of upgrades were available. Inspector records indicate that the monitoring system was not operable in 1990. The piping passed an integrity test performed in 1994.

Suspected Release Scenario

There was no information in the local agency file that indicates a new release point. One of the former tank owners has indicated that the UST system may need dispenser pans and overfill buckets. The MtBE contaminant data from the monitoring wells, coupled with a recent source area investigation, depicts the location of the USTs as the most likely source location. In 1996 however, the highest MtBE concentration was detected in MW-3 closer to the dispensers. The current MtBE contours coupled with the accumulation of free product in MW-4 in 1993 indicates that the tank area is a more likely source.

Conclusion

Due to the detection of free product in MW-4 in 1993 and the significantly increased MtBE contaminant trends, it appears that a release has likely occurred after the current UST system was installed and went undetected by the UST leak detection monitoring system.

SITE NUMBER 22

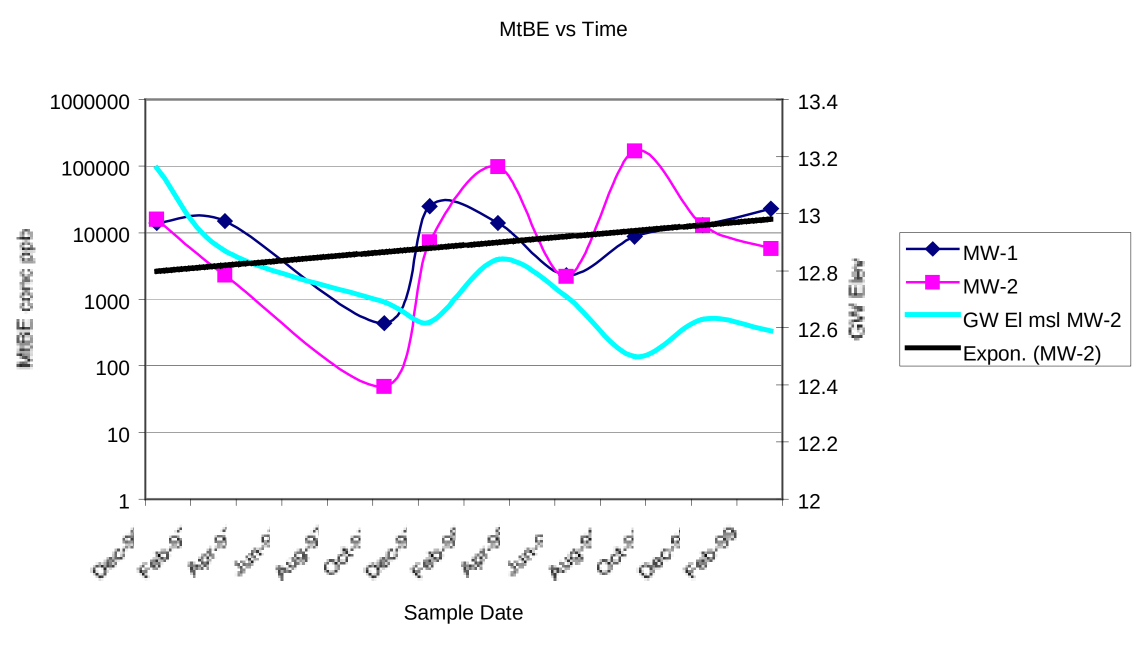
Fuel Leak History

A release was discovered when double-walled tanks and piping were installed in 1987. An Unauthorized Release Form (URF) was filed in January 1988 after contamination. No other releases have been reported.

MtBE Trend Analysis

Quarterly groundwater monitoring began in 1990. With the exception of very low detections on two events, the wells have not contained detectable TPHG or Benzene from 1990 to 1997. The highest concentration of TPHG detected was 7,500 µg/L in March 1998 and the highest Benzene concentration was 290 µg/L in March 1999.

Quarterly analyses for MtBE began in December 1996. Both of the source area wells (MW-1 and MW-2) had over 10,000 µg/L MtBE detected. The MtBE concentrations have fluctuated in these wells, but have been generally increasing. The highest MtBE concentration detected was 170,000 µg/L in MW-2 in September 1998. MtBE concentrations in this well have declined to 5,800 µg/L. Due to previously dramatic MtBE concentrations in this well, it is probable that concentrations may increase again. The cause of the fluctuations is unclear, but could be attributed to intermittent releases or spills, changes in groundwater elevation or changes in groundwater flow direction.



UST System Information

Double-walled tanks and piping (Total Containment–Flex) were installed in 1987. Overfill and overspill prevention components were also installed. The new tanks are installed in a different location than the previous tanks. Tank tightness tests were performed in 1997 and passed. Overfill containment, sumps, and dispenser pans were tested in 1998. Two dispenser pans and all STP sumps showed water loss during a lake test and were subsequently repaired.

Suspected Release Scenario

Both of the wells with significant contamination appear to be installed within the backfill of the new tanks (80 feet cross gradient of the former tanks). The well nearest the former tanks has been historically nondetect for all constituents except for one occasion in 1993. MtBE has been detected at significant concentrations since analyses began and the concentrations depict an increasing trend. The tank area is most suspect. The well with the highest concentrations is located at the end of the tanks where the product and vapor lines connect. Based on the observation of failed secondary containment at the sumps, it is likely that a release occurred undetected at this location. If the sump fails to hold liquid, the sensors cannot detect a small leak that may otherwise be captured and accumulate in the sump.

In addition, modeling performed by the consultant indicates that the release likely occurred in 1994 or 1995 (at least 7 years after new USTs installed).

Conclusion

Due to the significant and increasing MtBE concentrations at the new UST location, shallow depth to water, the long time elapsed since the new tanks were installed, and modeling that estimates the release occurred in 1994 or 1995, it appears that a release occurred from the current UST system and went undetected by the UST leak detection monitoring system.

SITE NUMBER 29

Fuel Leak History

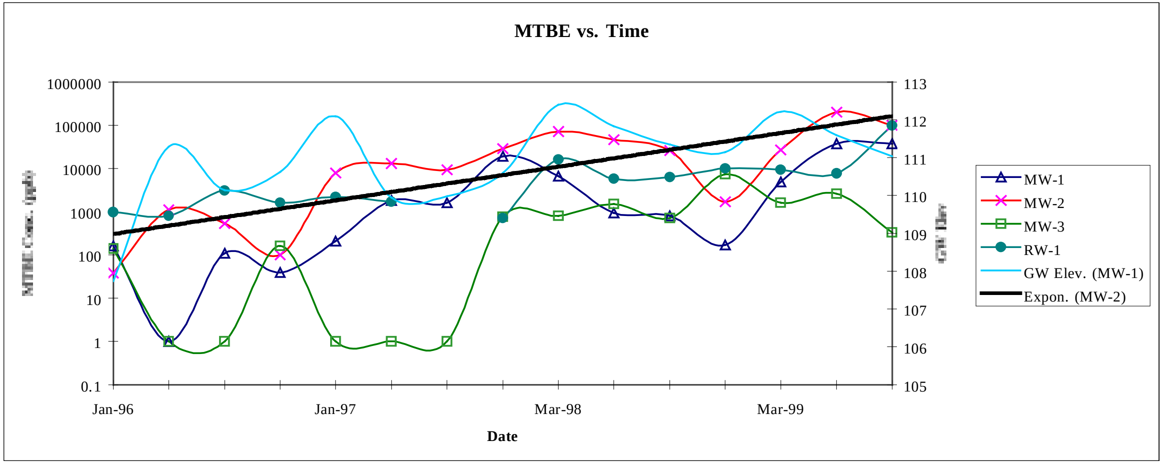
A URF was filed for a release in January 1996 due to a failed vapor piping test. The piping was subsequently repaired. Free product was detected in a Pollulert well located adjacent to the UST on June 30, 1987. The UST system was replaced with double-walled tanks and fiber trench piping in 1988. The former steel tanks were noted to have holes. No releases have been reported since the new tanks were installed.

MtBE Trend Analysis

Three borings and four monitoring wells were installed at the site in July 1987. Soil and groundwater contamination was detected. The site has been on a quarterly groundwater sampling program since August 1987. The USTs were removed in February 1988. Measurable thickness of free product has been detected in MW-3 (60 feet downgradient of the tank pit) on three separate monitoring events. But, measurable free product thickness has not been detected at the site since September 17, 1990. MW-3 has and continues to exhibit the highest dissolved TPHG concentrations. The highest concentration detected in June 1999 was 36,000 µg/L TPHG in MW-3. Overall, TPHG concentrations are declining is all wells, with MW-3 exhibiting steady state concentrations over the last 5 years.

MtBE analyses were first performed in June 1992. The highest concentration detected was 1,400 µg/L MtBE. Regular MtBE analyses began on January 1996 with concentrations up to 980 µg/L. Most wells had less than 100 µg/L MtBE. However, significant increases in MtBE concentrations were observed in monitoring wells MW-1, MW-2, MW-3, and RW-1 (several orders of magnitude in two of the wells from 1996 to 1997). The highest concentration of MtBE 200,000 µg/L was detected in June 1999 in MW-2 (west of the tank pit area).

A groundwater extraction system has been operating since February 1993 and is extracting from MW-1 and MW-3.



UST System Information

Double-walled tanks and fiber trench piping were installed in 1988. Overfill protection and spill prevention components were also reportedly installed. It is not clear if the trench liner was extended to beneath the dispensers for under dispenser containment. All of the UST system information could not be verified during site inspection.

Suspected Release Scenario

Inspector notes indicate that water had accumulated in the sumps in 1990, but was subsequently pumped out. A site inspection performed in 1998 did not reveal any obvious leaks. However, it was noted that the piping trench is not being properly monitored and it was discovered that vapors were detected in the interstitial space of the super-unleaded tank at 30 percent LEL. The source of the vapors was not determined.

Available analytical data indicates that MtBE was detected in groundwater in early 1992. It is possible that the MtBE detected in 1992 could be related to a release from the former UST system. However, due to the chemical characteristics of MtBE, small volume of MtBE in pre-1988 gasoline in the Bay Area, and the significantly increased concentrations (up to 200,000 µg/L) detected in 1999, it is unlikely that these significant MtBE concentrations are associated with the pre-1988 release. Groundwater contaminant concentration contours depict the UST area as the most likely source. Since the trench system likely drains back to the tank area it is not possible to conclude that the tanks themselves are a source of a recent release.

Conclusion

Due to the significant increases in MtBE concentrations near the tank pit, the long time elapsed since the previous release, it appears that a release occurred from the current UST system and went undetected by the UST leak detection monitoring system.

SITE NUMBER 6

Fuel Leak History

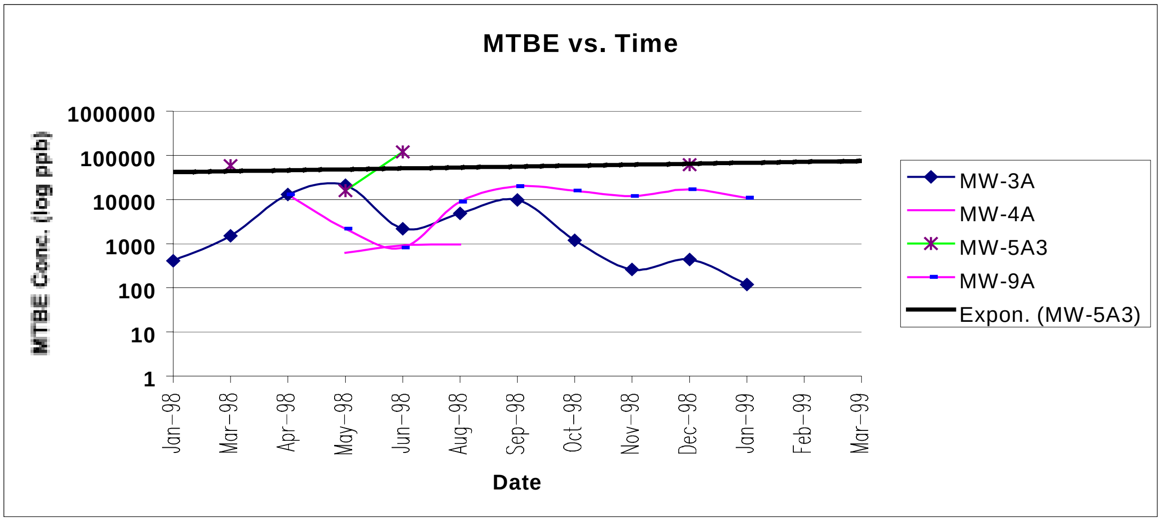
In 1987, a double-walled tank was installed and the former piping was replaced with fiber line trenches. No release was detected during these activities. The first detection of a release at this site occurred in 1990 when two tanks were replaced with double-walled tanks and up to 0.13 µg/L Benzene in soil beneath former tanks. No further investigation was required and the case was closed in 1991. In 1994, the piping was replaced with double-walled piping. The inspector did not require soil samples to be collected.

A URF was filed on January 20, 1998, as a result of subsurface monitoring. The subsurface investigation was performed in response to detection of MtBE in a nearby municipal supply well.

MtBE Trend Analysis

The highest MtBE concentration in groundwater was 140,000 µg/L in February 1998 at MW-6 at the north end of the tank pit. Concentrations declined to 11,000 µg/L in August 1998 at MW-6 (due to the lack of monitoring data for MW-6, it is not included in the graph). Well MW-6 is now connected to a remediation system and is no longer monitored. MtBE concentrations in MW-5 on the south end of the tank pit have increased from 20,000 µg/L in March 1998 to 120,000 µg/L in August 1998. This well was also connected to the remediation system. Some Benzene and TPHG have been detected in these wells, up to 610 µg/L and 740 µg/L, respectively. Most other wells have MtBE only contamination.

Significant concentrations of MtBE were also detected in soil (up to 100 parts per million (ppm)) around the tank pit in 1998, and little to no TPHG or BTEX. A soil vapor extraction system was started in May 1998 and may be assisting in lowering concentrations in some of the wells. In addition, a groundwater extraction system has also been started at the site.



UST System Information

The site currently has double-walled tanks (1990) and double-walled piping (1994), and meets the 1998 upgrade requirements.

Suspected Release Scenario

Due to the significant concentrations of MtBE detected in soil and water near the tank complex, it appears that the release occurred undetected sometime after the 1990 upgrade work. It is possible that the release could have been from the single-walled trench piping and was not detected at time of replacement because no soil samples were required. Recent information from the tank owner indicates that after multiple attempts to locate a release point, the release point has been identified. They believe that a vapor phase release associated with an assisted vapor recovery system is the cause. Several breaches which could provide vapor release points in the system have been identified during system inspections and include: abandoned overfill containment assemblies, deteriorated fill caps and tube baskets, and poor seals around sumps and electrical fitting penetrations. The deficiencies have been repaired and due to continued declining vapor and groundwater concentrations the owner believes the release to be abated.

Conclusion

Due to the significant MtBE contamination, long time elapsed since the reported release in 1989, and identification of a release source, it appears that the release occurred from the current upgrade compliant UST system and went undetected by the UST leak detection system.

SITE NUMBER 18

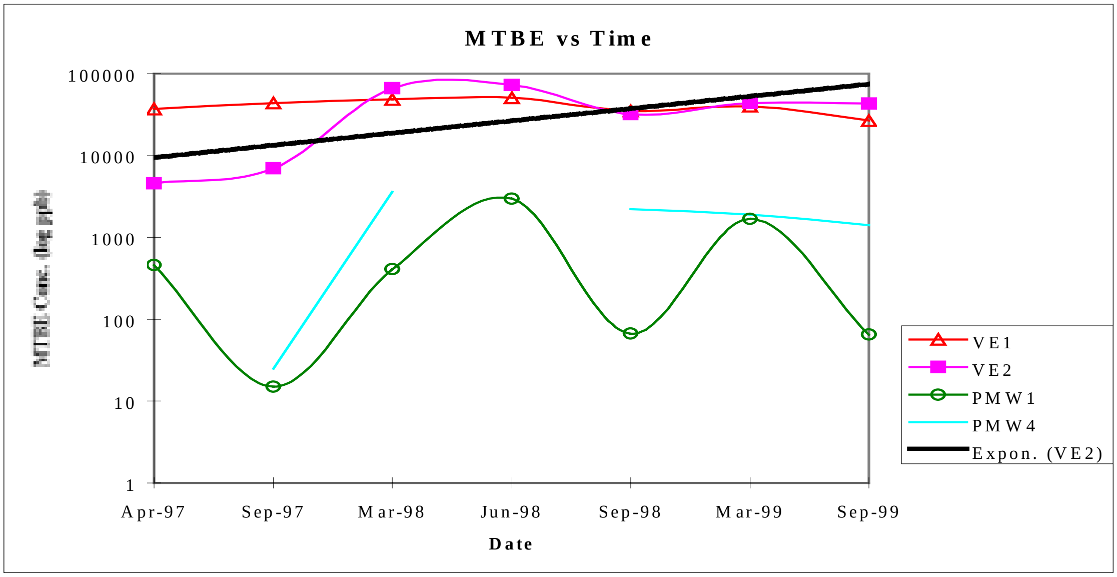
Fuel Leak History

A URF was filed for a release in February 1985. The cause of the leak was a structural failure discovered at the tank closure. (District records indicate that leak was discovered during pump island work and product was detected in soil). A second URF was filed on March 1990 due to contamination discovered at time of tank removal. In addition, 50 gallons of product was spilled when a fiberglass tank ruptured upon removal. Significant concentrations of petroleum hydrocarbons were detected at 14 feet and 21 feet bgs in soil. However, three soil borings drilled at the tank pit 3 months later did not detect any significant concentrations until approximately 30 feet bgs, indicating that an older release may have migrated through the permeable soils from 10 feet to 30 feet bgs (depth to water greater than 30 feet).

MtBE Trend Analysis

Groundwater was not encountered in borings drilled to a maximum depth of 80 feet bgs in 1990 or 1991. However, groundwater was encountered in 1992 at a depth of 35 feet bgs. Grab groundwater samples were collected during drilling and contained up to 29,000 µg/L TPHG and 1100 µg/L Benzene.

Vapor extraction wells were installed in 1994. Groundwater samples were collected from these wells and contained up to 69,000 µg/L TPHG and 13,000 µg/L Benzene. Regular monitoring of the wells did not begin until 1997 and is being conducted semiannually. TPHG and Benzene concentrations remain high in the source area wells. BTEX and TPHG were all high during the last two sampling events. The highest TPHG concentration was 120,000 µg/L in September 1998. The highest Benzene concentration was 13,000 µg/L on July 1994 and is currently at 9,900 µg/L.



MtBE was first detected, but not quantified, in well PMW4 in November 1995. MtBE concentrations in VE-2 increased by an order of magnitude between the September 1997 and

March 1998 sampling events. The highest and current level of MtBE is 73,000 µg/L detected in June 1998 in VE-2. The MtBE concentrations in the other source area well (VE-1) have remained above 30,000 µg/L since April 1997. Increasing concentrations are also being observed in PMW-4 near the dispensers.

UST System Information

Two double-walled fiberglass clad steel USTs were installed in 1990. Singled walled piping in a fiber trench was also installed in 1990. A site inspection revealed that the trenches might not drain into the sumps. There were nonfunctional probes and a leaking dispenser observed during the inspection.

Suspected Release Scenario

The UST system meets the 1998 upgrade requirements. However, it appears that the station was not in operation from 1996 until an unknown time in 1998. Inspector notes from 1992 to 1996 indicate several monitoring equipment problems. A source area soil and water investigation was conducted in 1998 and did not result in evidence of a new or ongoing release. With the exception of one location, no shallow soil contamination was detected. The groundwater data indicates the most significant contamination is near the tank complex. VE-2 nearest the fill end of the tanks has shown the greatest increasing MtBE trend.

Conclusion

Based on the inspector notes and site inspection, there is a potential for releases to go undetected at the site. However, based on the recent soil investigation, there is no evidence of an ongoing or recent release other than the increasing concentrations of MtBE at VE-2. The data does not allow for a conclusion of whether the MtBE is related to the pre-1990 release or an undetected release from the current UST system. However, it does appear that a release occurred from the former UST system that was not detected by the UST leak detection monitoring system.

SITE NUMBER 12

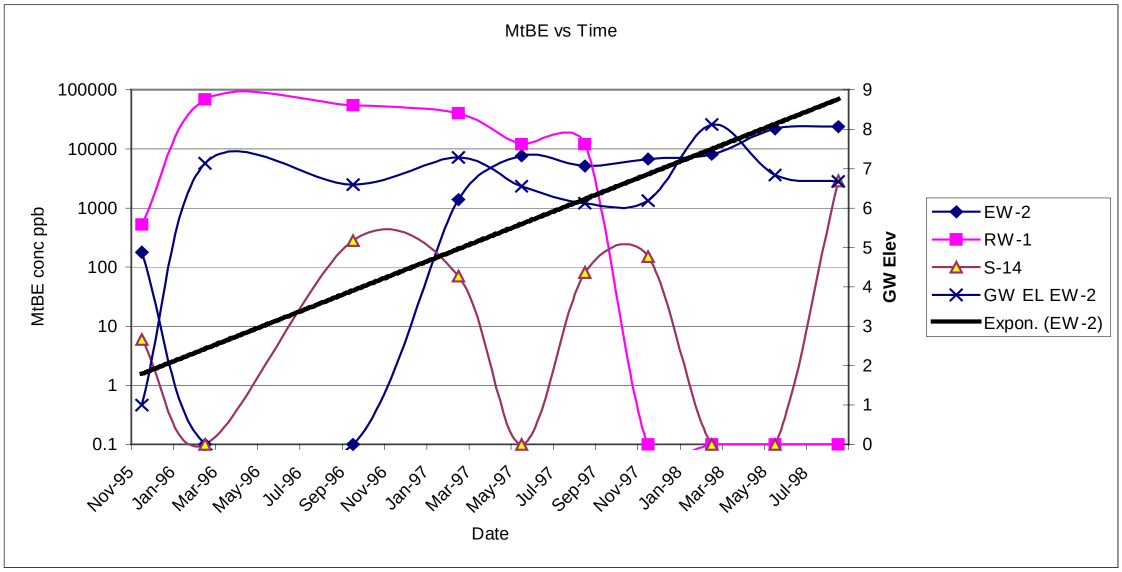
Fuel Leak History

Free product was observed during installation of leak detection monitoring wells in February 1988. The former single-walled fiberglass tanks were replaced with double-walled fiberglass tanks in 1989. No releases have been reported since the tanks and piping were replaced.

MtBE Trend Analysis

Three groundwater monitoring wells were installed in 1988. Reportedly there were also leak detection wells which contained free product. However, the quarterly groundwater monitoring results do not indicate that product was observed at that time. Up to 4,800 µg/L Benzene was detected in groundwater in 1988. By 1993, free product was observed in two of the wells EW-2 and RW-1. Product continued to be intermittently observed in RW-1 to 1994. Up to 180,000 µg/L TPHG and 6,900 µg/L Benzene have been detected in groundwater in EW-1. In general, petroleum hydrocarbon concentrations are on a decreasing trend. Dissolved petroleum hydrocarbon concentrations depict an increasing trend from 1989 to 1993 in RW-1. Significant decreasing trends were observed in EW-2 and EW-1.

MtBE analyses were initiated in November 1995. The highest concentrations detected at the time were 2,200 µg/L MtBE in EW-1 and 530 µg/L in RW-1. By the next quarter, MtBE concentration in RW-1 increased to 69,000 µg/L, the highest MtBE concentration detected to date. Concentrations in this well subsequently declined to 12,000 µg/L in November 1996, but the well has not been sampled since. The most significant increasing MtBE trend observed was EW-2 that has steadily increased from 180 µg/L to 24,000 µg/L.



UST System Information

Three double-walled fiberglass gasoline USTs and piping were installed in 1989 and were equipped with overfill protection devices. A report in 1998 indicated that upgrade work was planned for the site, but no other information is available to indicate which components required upgrade work.

Suspected Release Scenario

Groundwater analytical data indicates a generally decreasing trend of TPHG and Benzene. MtBE concentrations were most significant in RW-1 and have shown an increasing trend in EW-2 and S-14. Isoconcentration contours do not clearly indicate which portion of the system is the most suspect source area, but the tank cavity appears the most likely based on the concentration data from EW-2 and RW-1 (adjacent to tanks, fifty feet cross gradient from the dispensers). In addition, a local agency file review indicates that sumps have been in alarm due to water infiltration and that a leak from the secondary portion of the plus tank was observed by water in the interstitial space. It is not clear whether the tank was repaired. The spike of MtBE in RW-1 correlates with the observed problems with the tanks. A report submitted by the responsible party's consultant in 1998 states that the plume appears to be 6 years old based on a modeling prediction.

Conclusion

This site should meet the 1998 upgrade standards since the UST system was replaced in 1989 (after new and upgrade UST requirements became in effect). However, there may have been some ancillary upgrade work performed in 1998. The facility has had repeated problems with water intrusion into sumps and on at least one occasion into the interstitial space of a tank. **Due to increasing MtBE contaminant trends with decreasing TPHG trends, modeling prediction that the release occurred in 1992, and inspection records indicating problems, it appears that a gasoline release has occurred from the current UST system and was not detected by the UST leak detection system.**

SITE NUMBER 9

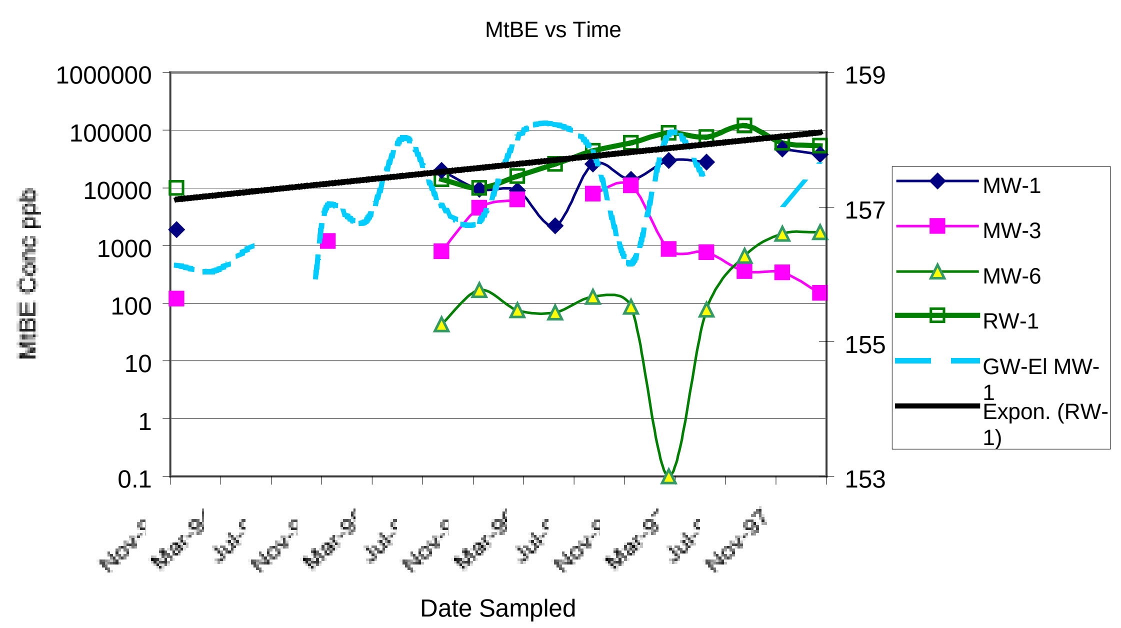
Fuel Leak History

An investigation was initiated in 1988 due to contamination observed when a waste oil tank was removed. A URF was filed in June 1989 for a release associated with a waste oil tank. A gasoline release has never been reported at this site, yet there is extensive gasoline pollution.

MtBE Trend Analysis

Three groundwater monitoring wells were installed in 1990. Up to 10 µg/L Benzene was detected in groundwater. By 1992, free product was observed in one of the wells. Product continued to be intermittently observed in MW-1 to 1996. Up to 140,000 µg/L TPHG and 1,300 µg/L Benzene have been detected in groundwater in MW-1. Up to 110,000 µg/L TPHG and 9,100 µg/L Benzene have been detected in monitoring well RW-1. In general, dissolved petroleum hydrocarbon concentrations show an increasing trend from 1990 to 1996.

MtBE analyses were performed for most wells in 1993. Up to 10,000 µg/L was detected during this sampling event. MtBE analyses restarted on a quarterly basis in 1995. MtBE was not detected in any well in August 1995. Up to 20,000 µg/L and 140,000 µg/L MtBE were detected in MW-1 and RW-1 respectively. MtBE concentrations showed a steady increase in RW-1 and MW-7 until August 1997 when a high of 120,000 µg/L was detected in RW-1. Concentrations have remained very high in the source area wells.



UST System Information

One 12,000-gallon, one 10,000-gallon, and one 6,000-gallon single-walled fiberglass USTs were installed in 1983. The single-walled fiberglass piping was contained within a fiber trench (1983). The tanks and piping passed several integrity tests from 1990 to 1994. The site has had several problems with water intrusion into the sumps and piping trench and failures of the leak detection equipment. During August 1998 upgrades not required under the 1998 upgrade requirements were being made (dispenser pans and turbine sumps).

Suspected Release Scenario

In March 1989 a soil vapor survey was conducted. The contractor determined that the isoconcentration contours depicted two release areas: north of the westerly pump island (upgradient of RW-1) and between the tank and eastern pump islands (upgradient of MW-1).

The highest and current level of MtBE was on August 8, 1997, of 120,000 µg/L in RW1 (dispenser island area). High BTEX and TPH levels are also present in the well. The release scenario analysis is inconclusive, but the release could be related to sump or leak detection monitoring problems.

Conclusion

This site appeared to meet the 1998 deadline standards prior to the recent upgrades that were not required under the 1998 deadline. It is difficult to determine if the trenches or the rest of the UST system were being properly monitored. The facility has had repeated problems with monitoring equipment and water intrusion into sumps and trenches. **Due to contaminant trends and inspection records indicating problems, it appears that a gasoline release has occurred from the UST system in use from 1983 to 1998 and was not detected by the UST leak detection system.**

SITE NUMBER 7

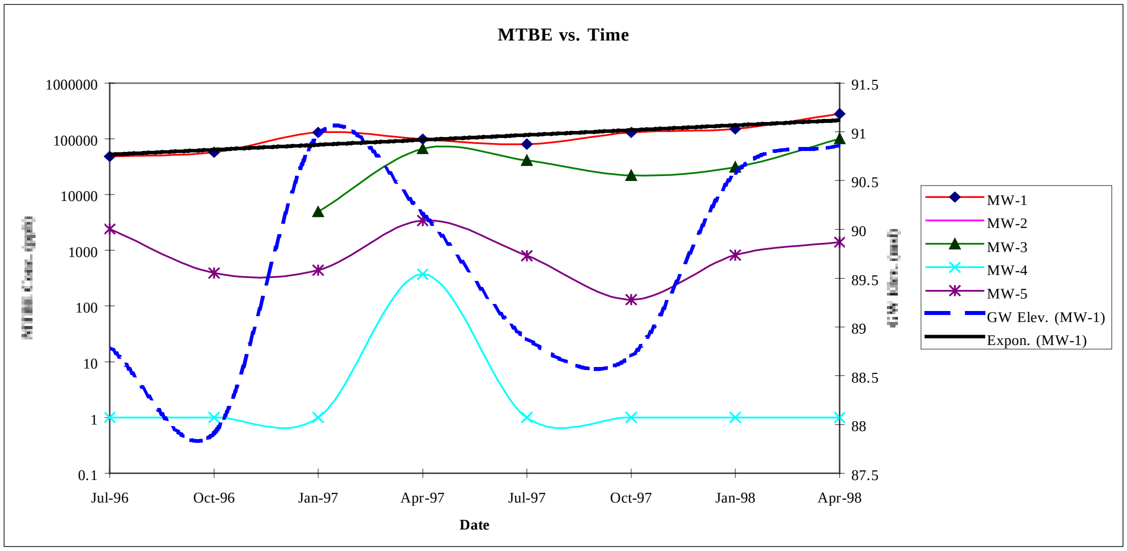
Fuel Leak History

The first release was discovered and reported in 1986 during tank replacement activities. Four tanks were replaced with 3 double-walled tanks. No release has been reported since the installation of the double-walled tanks in 1986.

MtBE Trend Analysis

One groundwater sample was collected in 1985 that indicates 27 µg/L TPHG was detected. Groundwater monitoring began on a quarterly basis in 1990. Generally low levels of petroleum hydrocarbons were detected from 1990 to 1993, when moderate concentrations were detected in the source well (MW-1). The most significant concentrations were detected in 1994 and 1996. Concentrations detected in 1997 are generally declining. TPHG and Benzene remain at 1,000 to 3,000 µg/L and ND to 100 µg/L, respectively. However, 1998 data indicates more significant concentrations of TPHG and Benzene upgradient of the USTs. 230,000 µg/L TPHG and 13,000 µg/L Benzene were detected in a geoprobe sample approximately 10 feet upgradient of the USTs. These concentrations indicate that Nonaqueous Phase Liquid (NAPL) may be present.

MtBE analyses began in July 1996. The first sample collected from MW-1 contained 47,000 µg/L MtBE. MtBE concentrations have shown an increase in this well, with the highest concentration of 280,000 µg/L detected in April 1998. The lowest concentrations have been found in July of 1996 and 1997, but have not declined below 47,000 µg/L.



UST System Information

Three double-walled USTs and piping in a fiberglass trench were installed in 1986.

Suspected Release Scenario

Groundwater analytical data indicates increasing trends of both petroleum hydrocarbons and MtBE in MW-1. The TPH data shows the most significant increases in concentrations in 1994, eight years after UST replacement. Due to the increases in MtBE since 1996 and TPH since 1993 and the low volumes of MtBE in use in the Bay Area prior to 1986, it appears that the groundwater pollution is not likely related to the release stopped in 1986. However, since TPH and Benzene have been increasing since 1986 it is possible that the pollution is from a release stopped over 12 years ago. If the current groundwater contamination is related to the release stopped in 1986, it may indicate that significant residual sources or NAPL are still present and MtBE was used in significant quantities in the early 1980s.

The isoconcentration contours depict the highest concentrations at the UST system. However, there is not sufficient data available for conditions near the piping or pump islands to rule these portions of the system as likely sources.

Conclusion

Due to the significant concentrations of MtBE, increased concentration, and the time elapsed since the current tank system was installed, it appears that a release occurred from the current UST system and went undetected by the UST leak detection system.

SITE NUMBER 10

Fuel Leak History

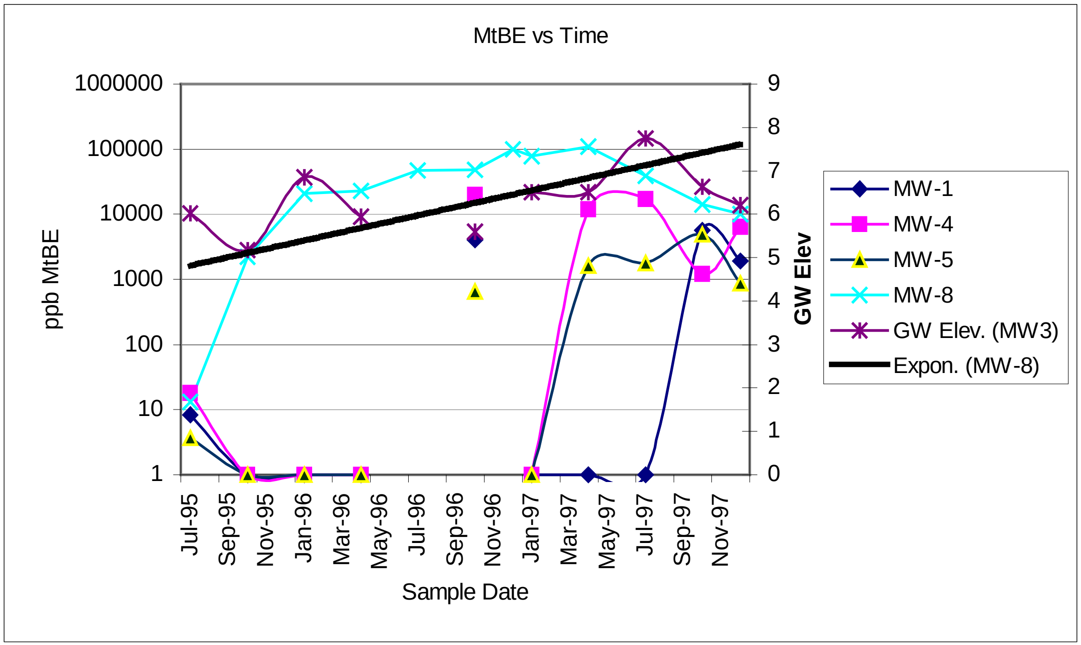
The first release was discovered and reported in 1988 when a soil and water investigation was conducted and low levels of dissolved petroleum hydrocarbons were detected in 3 monitoring wells. The USTs were removed and replaced in June 1991. More significant concentrations of TPHG and BTEX were detected in the soil and water samples collected after system removal.

No releases have been reported since the tanks were replaced.

MtBE Trend Analysis

Low levels of TPHG and Benzene (maximum of 1,300 µg/L and 16 µg/L, respectively) have been detected in groundwater monitoring wells from 1988 to 1992. Since that time, most water samples have been nondetectable for TPHG and Benzene.

MtBE analyses began in July 1995. The highest concentration detected in July 1995 was 18 µg/L. MtBE concentrations steadily increased in the source well (MW-8) by an order of magnitude for the next two sampling events. The highest concentration was detected in December 1996 at 110,000 µg/L in MW-8. Since December 1996, MtBE concentrations have declined to 10,000 in MW-8. Two other monitoring wells have also shown increasing trends. The 10,000 µg/L MtBE isoconcentration contours extends more that 120 feet from the source. The plume has not been defined to nondetectable levels, but extends to approximately 400 feet.



UST System Information

Double-walled tanks and piping were installed in June 1991. Records indicate that spill and overfill prevention, sumps, and dispenser pans were also installed at that time. The UST system passed integrity tests in February 1996. In December 1997 tests were also conducted on the vapor and vent lines with passing results. Additionally lake tests were performed on the overfill containers, STP, sumps, and dispenser pans. All dispenser pans showed up to 95 percent water loss. Water from the dispenser pans drained into the secondary containment piping and into the STP sumps. Cracks were observed in the secondary containment boot connection in the dispenser pans. The STP sump for the Super grade fuel showed 90 percent water loss.

Suspected Release Scenario

Due to the low and decreasing concentrations of TPHG and Benzene and significant increases in MtBE concentration, it appears that the plumes are unrelated and the MtBE is not likely associated with the release reported and stopped in 1991. The isoconcentration contours for MtBE depict the sump ends of the tanks as the most probable source locations. Since the primary components of the UST system appear to be intact, and problems with the STP sump have been observed, it is likely that a temporary release could have occurred at this location, without being detected. The spike and subsequent decline in MtBE concentrations in MW-8 at the edge of the tank pit supports the conclusion of a temporary release. The components that were noted as having problems in December 1997 have been repaired, and therefore the source area concentrations (MW-8) should continue to decline.

Conclusion

Due to increasing MtBE trends, low and decreasing TPHG, and time elapsed since the previous release, it appears that release occurred from the current UST system and was not detected by the UST leak detection system. Problems observed with the UST system have been repaired and the release appears to have been temporary in nature.

SITE NUMBER 13

Fuel Leak History

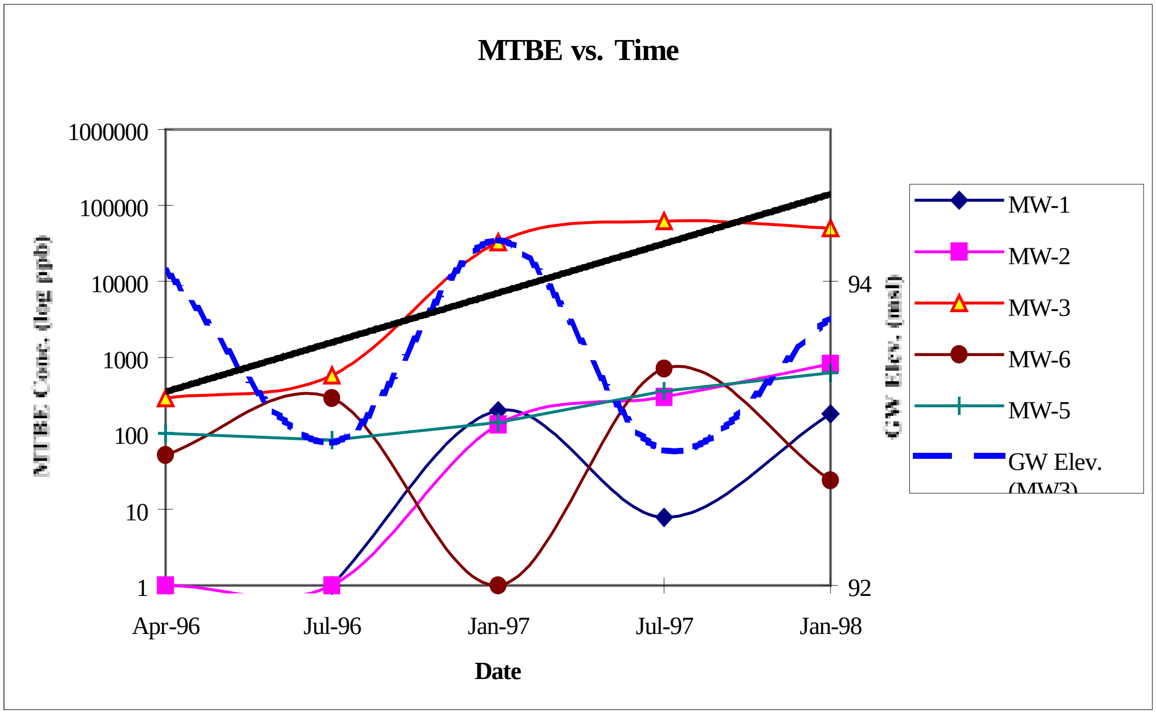
The first release was detected and reported in 1990 when the UST system was removed in 1990. The tanks were replaced with double-walled reinforced fiberglass plastic (RFP) clad steel and the piping with double-walled fiberglass.

No releases have been reported since the tanks were replaced.

MtBE Trend Analysis

Significant concentrations of dissolved TPHG and Benzene have been detected in groundwater since 1991. The highest concentrations of TPHG and Benzene were detected in 1992. Concentrations have been variable, but the TPHG has declined by an order of magnitude in some of the wells.

MtBE analyses began in April 1996. Up to 290 µg/L was detected in April 1996. By January 1997, MtBE concentrations in MW-3, downgradient of the USTs, had increased to 33,000 µg/L. The highest concentration of MtBE detected as of January 1999 was 130,000 µg/L. The MtBE plume appears to be spreading laterally at low concentrations (less than 1,000 µg/L).



UST System Information

Double-walled tanks and piping were installed in 1990. The UST system is equipped with overfill and spill prevention and dispenser pans. Upon inspection by the UST Advisory Panel, 100 percent LEL was measured in the interstitial space of the double-walled tank. In addition, there was product in the sump and the sensor was raised.

Suspected Release Scenario

Due to the significant increases in MtBE concentrations near the USTs, generally declining TPHG and Benzene concentrations, and low volumes of MtBE used in this area before 1990, it appears that the MtBE is not attributable to the release that was stopped in 1990. The source area appears to be in the general vicinity of the USTs or piping near the USTs. The UST system has been inspected and the leak detection monitoring system has been tested. The only problem observed was the positive shut down was not operational upon an inspection in 1995. No source of this release can be identified at this time.

Conclusion

Due to increasing MtBE contaminant trends and distribution, and the time elapsed since UST replacement, it appears that a release from the current UST system occurred and went undetected by the UST leak detection system.

SITE NUMBER 3

Fuel Leak History

First release reported in 1984. Leaks discovered in piping and turbines in 1987 and 1988, respectively. Free product noted in 1988 until 1992.

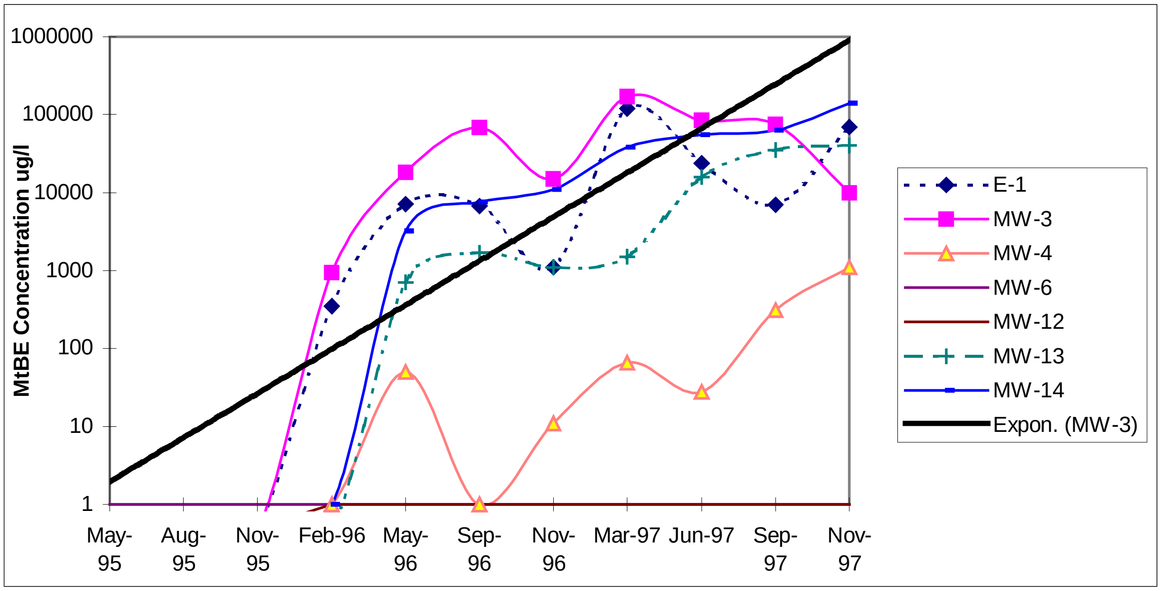
Tank and piping system replaced with double-walled system in 1989.

From 1991 to 1997, various local agency inspections revealed probes were out of order. However, no releases have been reported since the installation of the new system in 1989.

MtBE Trend Analysis

Significant concentrations of dissolved TPHG and Benzene have been observed since 1992 when free product removal was completed. The dissolved concentrations remain high, but have decreased in most wells. No increased concentrations of the petroleum hydrocarbons have been observed.

MtBE analyses began in February 1996. The highest concentration of MtBE in February 1996 was 1,000 µg/L. At this time the MtBE plume appeared relatively small and localized. MtBE concentrations increased by an order of magnitude in several monitoring wells over the next few quarterly monitoring events. The maximum concentration observed to date was detected in monitoring well MW-3 in March 1997 at 170,000 µg/L. By November 1997 the concentration in this well decreased to 70,000 µg/L. However, during the same sampling event 140,000 µg/L was detected in monitoring well MW-14 located 160 feet downgradient of the tank system.



UST System Information

Three double-walled tanks and double-walled piping were installed in June 1989.

Suspected Release Scenario

Due to the decreases in TPH and BTEX, the absence of free product since 1992, and relatively faster dissolution of MtBE, (relative to TPH and BTEX) it is not probable that the MtBE is associated with the release stopped in 1989. In addition, a depth discrete investigation has been conducted to 123 feet bgs. MtBE was not detected greater that 1,000 µg/L below 36 feet. However, very high concentrations of TPH and BTEX have been detected to 123 feet bgs. Therefore, it appears that migration of TPH and BTEX has occurred over a longer time period than MtBE. Isoconcentration contours of MtBE depict the tanks or piping as the most likely source area.

Conclusion

Due to the decreases in TPH and BTEX, the absence of free product since 1992, and the increases in MtBE concentration, it appears that a release occurred from the current UST system and went undetected by the UST leak detection system.

SITE NUMBER 5

Fuel Leak History

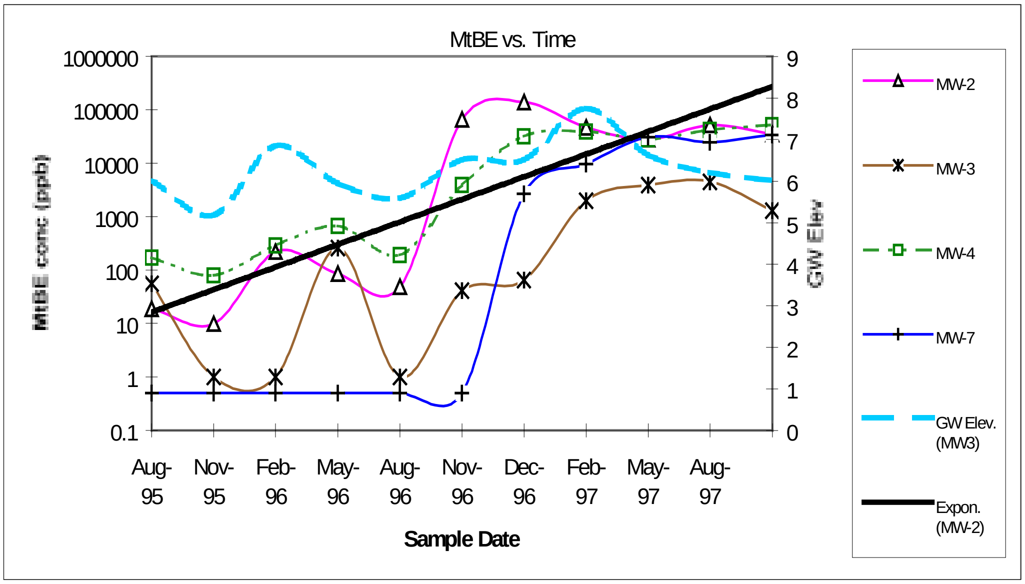
First release reported in December 1983 due to 700 gallon inventory loss. The leaking tank was removed in January 1984. All tanks and piping were removed and replaced with a double-walled system in December 1991. The only soil contamination observed at the time of tank removal was located on the eastern end of the north tank. The eastern dispenser islands were taken out of service at an unknown date.

No releases have been reported since the new tank system was installed. Local agency inspection records from 1997 state that this station is very well maintained.

MtBE Trend Analysis

Groundwater monitoring for TPH and BTEX began in 1991. The data set indicates two separate TPH plumes. One plume appears to be originating from the eastern end of the former north tank. The other plume appears to be originating from the former eastern fuel island. The TPH and BTEX data indicate a significantly decreasing trend.

MtBE analysis began in August 1995. The highest concentration detected in August 1995 was 170 µg/L. MtBE was not detected above 1,000 µg/L during the first 5 quarters of sampling (August 1995 to August 1996). In November 1996 the MtBE concentrations increased by more than two orders of magnitude in two of the wells. The maximum concentration of MtBE detected to date was 140,000 µg/L in November 1996 in MW-2 (downgradient of the fill end of the new tank system). Subsequent sampling events in this well have not exceeded 54,800. The trend in this well has decreased since November 1996. However, the downgradient wells are showing moderate to high increases in concentrations.



UST System Information

Three double-walled tanks and piping were installed in late 1991 to early 1992.

Suspected Release Scenario

Due to the significant reduction in TPH and BTEX concentrations since 1994 and 1995, and the initially low levels of MtBE in the wells with the highest TPH and BTEX, it is not likely that the MtBE is associated with the known TPH and BTEX releases stopped prior to 1992. In addition, the isoconcentration contours of MtBE compared to the TPH/BTEX contours depict separate source areas. For example, monitoring wells MW-2 and MW-4 have the highest MtBE concentrations and have not had significant concentrations of TPH and BTEX since monitoring began 1991. The MtBE contours depict the fill end of the new tanks or vent line connections as the most probable source location.

Conclusion

Due to the increasing MtBE concentrations, decreasing TPHG concentrations and distribution of MtBE at the new UST location, it appears that a release occurred from the current UST system and went undetected by the UST leak detection system.

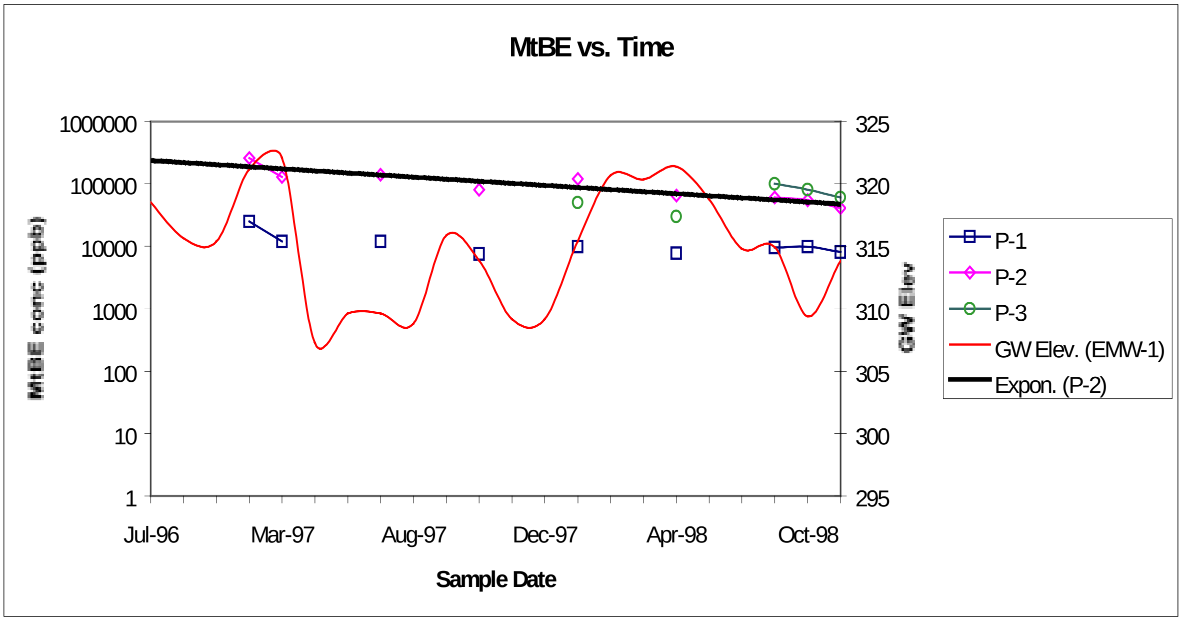
SITE NUMBER 2

Fuel Leak History

The first and only release was discovered and reported in June 1995. Odors were detected in the bathrooms at the site and subsequently vapors were detected in at an off-site sanitary sewer. This led to tank integrity testing which detected a leak in the primary piping. The product drained down the secondary piping to the turbine sump. The sump did not contain the product and the liquid sensors never went into alarm. The piping was then replaced.

MtBE Trend Analysis

Two of the wells installed after the release contained floating product. TPHG and Benzene concentrations in two of the source areas wells increased to an all time high in 1996, 320,000 µg/L and 53,000 µg/L, respectively (one year after the release was discovered and stopped). Analyses for MtBE in the source area wells did not begin until 1997. Up to 260,000 µg/L MtBE was detected in the source area wells (the highest MtBE concentration detected to date). Concentrations have declined since MtBE monitoring began. This decline in concentrations is a result of the leak being stopped and interim remedial measures performed over the last few years.



UST System Information

The double-walled gasoline UST, piping, sumps, and overfill protection components were installed in 1987.

Suspected Release Scenario

There is not clear documentation of why the sump did not contain the leaking product or why the liquid sensors did not detect the release. However, it has been demonstrated that the release was a result of failed primary piping and ineffective secondary containment and leak detection.

Conclusion

It has been confirmed that the release at this site occurred after installation of the new UST System and went undetected by the UST leak detection system. The system has subsequently been repaired.

SITE NUMBER 8

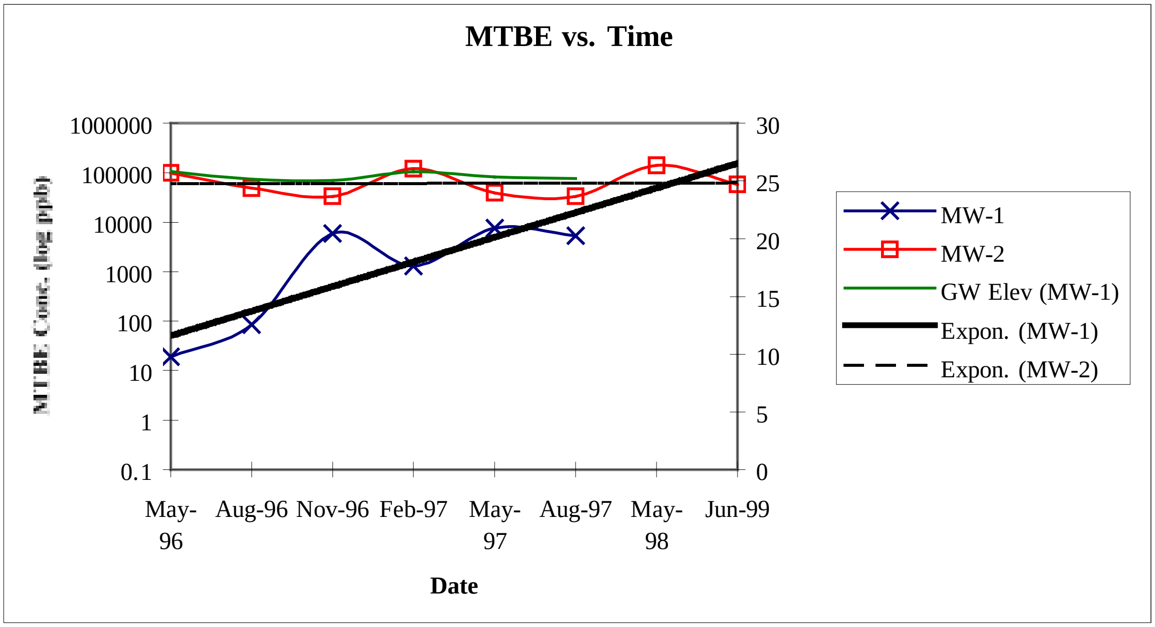
Fuel Leak History

A piping leak was discovered during installation of a piping leak detection well. The piping was replaced in 1986. The piping was replaced with double-walled construction. The tanks were replaced with double-walled construction in 1988. Holes were observed in the tanks. The piping and dispensers are in a new location. No releases have been reported since the tank replacement.

MtBE Trend Analysis

Groundwater sampling was initiated in 1989. The two wells sampled between 1989 and 1991 (MW-2 was dry until 1992) contained very low concentrations of TPHG and Benzene, 500 µg/L and 52 µg/L respectively. Groundwater samples from MW-2 in 1992 contained up to 19,000 µg/L TPHG and 2,300 µg/L Benzene. TPHG and Benzene concentrations have gradually declined and have not exceeded 5,000 µg/L TPHG and 500 µg/L Benzene since 1996.

MtBE analyses began in May 1996. MW-2 contained 99,000 µg/L MtBE. MtBE concentrations in this well have fluctuated but have exceeded 100,000 µg/L on two occasions (February 1997 and May 1998). The highest concentration of MtBE detected to date was 140,000 µg/L in May 1998.



UST System Information

Double-walled piping was installed in 1986 and double-walled tanks in 1988. Facility upgrade work performed during September 1998 included installation of tank top spill containment and replacement of the piping. It is not clear why the double-walled piping was replaced in 1998.

Suspected Release Scenario

Groundwater analytical data indicates high concentrations of MtBE in MW-2 between the tanks and the new piping location. The TPH data shows previously high but declining concentrations in MW-2. Isoconcentration contours depict the area of the piping/dispensers installed in 1986 as the most likely source area. Soil sampling conducted during upgrade activities in 1998 indicates low to moderate soil contamination beneath the piping/dispenser areas. Due to the high and steady MtBE concentrations, location of the highest MtBE concentrations at the new piping location, and the low volume of MtBE in use in the Bay Area prior to 1988, it appears that a release occurred after the piping and tanks were replaced in 1986 and 1988, respectively. However, since upgrade activities were conducted in 1998 the release may have been from a component that was not 1998 upgrade compliant.

Conclusion

Due to the high and steady MtBE concentrations, location of the highest MtBE concentrations at the new piping location, and the low volume of MtBE in use in the Bay Area prior to 1988, it appears that a release occurred from the current UST system and went undetected by the UST leak detection system.

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